



## OVERVIEW OF A POPULATION QUESTION

Since 2015 the journal has been publishing an annual chronicle reviewing current knowledge about a contemporary population issue. Aimed to provide a complete synthesis, the chronicles provide both factual data and accounts of theoretical and political debates on the issue to a wide readership (researchers and other scientists, students, journalists and others). They also contextualize the issue historically for a better understanding. After a critical description of information sources and measurement tools, the author or authors assess the most recent research studies of the question, presenting trends in the phenomenon together with the social and spatial disparities involved. This is followed by a discussion of some of the political, policy and/or legal implications of the current and future situation and challenges for future research.

The first *Population* chronicle was by Christophe Z. Guilmoto on masculinization of births (2-2015); the second by Armelle Andro and Marie Lesclingand on female genital mutilation (2-2016). This year's chronicle, by Dominique Tabutin and Bruno Masquelier, takes up an issue that looms large in demography and health policy research: mortality inequalities and trends in low- or medium-income countries from 1990 to 2015. The general improvement in health over the twentieth and early twenty-first centuries has benefited populations everywhere, but unequally by country. What is the situation today? Medical advances and socioeconomic development have been instrumental in the spectacular rises in life expectancy, even in the world's poorest regions, where life expectancy has now reached 61 years. A key question is whether the progress has benefited all populations equally, women and men, the very poor and the very wealthy, rural as well as urban dwellers, or whether health inequalities have instead deepened due, among other things, to the persistence of major social and economic inequalities within a great number of countries and across countries. The authors studied 109 low or medium-income countries representing 80% of the world's population, countries in which the health transition is at various stages of advancement. Despite the lack of data and of precise measurements of health inequalities, especially for adults, the authors found sharply contrasting trends from one country to another. They stress the need to develop research and public policies that will combat inequalities in health.

Olivia Samuel, Anne Solaz, Laurent Toulemon  
*Population* editors



## CONTENTS

### Mortality Inequalities and Trends in Low- and Middle-Income Countries, 1990-2015

I.	Geographical scope, data and methods .....	224
II.	Life expectancy at birth: progress but persistent inequalities .....	230
III.	Child mortality has halved since 1990, but large inequalities persist .....	240
IV.	Adult mortality: a moderate overall decrease .....	257
V.	A protracted epidemiological transition, with patterns that vary across social groups .....	270
VI.	Is mortality across countries converging or diverging? Is inequality within countries decreasing? .....	276
VII.	Uncertainties and knowledge gaps: consolidating research on mortality and its inequalities .....	278



Dominique TABUTIN\* and Bruno MASQUELIER\*

---

## Mortality Inequalities and Trends in Low- and Middle-Income Countries, 1990-2015

*“Nature creates differences, society turns them into inequalities”*

(Tahar Ben Jelloun)

Most countries in the world saw significant improvements in survival between 1990 and 2015. Over those 25 years, life expectancy at birth increased by 12 years on average in low-income countries, 7 years in middle-income countries, and 5 years in high-income countries (Appendix Table; United Nations, 2015).<sup>(1)</sup> There were gains across all the world regions, reaching 7 years in East and Western Asia, almost 8 years in Latin America, and 9 and 10 years, respectively, in the two regions that started with the biggest disadvantages, namely South-Central Asia and sub-Saharan Africa. Mortality declined in every age group, with the biggest improvements among children. Worldwide, the number of deaths before age five declined from 12.7 million in 1990 to 5.9 million in 2015 (UN IGME, 2015), and the under-five mortality rate fell from 91 to 43 deaths per 1,000 live births. However, improvements have not occurred evenly across all regions, countries, place of residence or social groups; cross-country inequalities in the chances of survival have also evolved over the past 25 years.

### *The international context*

The health gains observed over the past 25 years have been driven by unprecedented global mobilization to improve health for all. This includes the action of national governments, programmes supported by United Nations agencies and by the many donors active in the health sector, which encompass

---

(1) We used the World Bank's country classification by income level: low-income countries are defined as those with a gross national income (GNI) per capita (calculated using the Atlas method) of USD 1,045 or less in 2013; lower-middle-income countries are those with a GNI per capita between USD 1,046 and USD 4,125; upper-middle-income countries are those with a GNI between USD 4,126 and USD 12,745; high-income countries are those with a GNI per capita of USD 12,745 or more (2014 classification, used in the 2015 Revision of the World Population Prospects) <https://datahelpdesk.worldbank.org/knowledgebase/articles/906519-world-bank-country-and-lending-groups>.

\* Centre for Demographic Research, Université catholique de Louvain, Louvain-la-Neuve, Belgium.  
Correspondence: Centre for Demographic Research, Université catholique de Louvain, Louvain-la-Neuve, Belgium, email: dominique.tabutin@uclouvain.be

non-governmental organizations (NGOs), several large private foundations, such as the Gates Foundation, partnerships like the Global Alliance for Vaccines and Immunization (GAVI), the Global Fund to Fight AIDS, Tuberculosis and Malaria, and donor countries that provide funding for development assistance for health (Germany, United Kingdom, United States, etc.) (IHME, 2016).

The health of populations has improved in response to social progress over the past 25 years, even if gains in both areas are insufficient and vary greatly between regions. Globally, the number of people living in extreme poverty has been more than halved since 1990 (World Bank, 2016); education has improved in all countries and illiteracy has fallen (UNESCO, 2014); and many health indicators have improved (immunization coverage, safe delivery, etc.). The demography of low-and middle-income countries is changing. Fertility has fallen almost everywhere, albeit at varying speeds: in middle-income countries, it decreased from an average of 3.4 children per woman in 1990 to 2.4 in 2015, and in low-income countries from 6.4 to 4.7. Population growth slowed slightly, falling in middle-income countries from an average of 1.9% per year in 1990 to 1.1% in 2015, while in low-income countries the decrease was much smaller, from 2.7% to 2.6% (United Nations, 2015).

Those overall results, while positive, conceal large differences in trends, histories and timing between and within countries. Inequality is more than ever a top priority for programmes of action, international institutions and academic research.

Inequality is by no means a new issue, however. In 1979, the World Health Organization (WHO) adopted “Health for All by the Year 2000”, a global strategy that included ambitious goals for reducing child and maternal mortality by the end of the twentieth century. It came shortly after the Declaration of Alma-Ata in 1978 on primary health care, which was seen as key to reducing health inequalities. In 1994, the Programme of Action adopted at the International Conference on Population and Development (ICPD) in Cairo devoted one of 13 chapters to health and mortality, with the explicit aim of reducing inequalities in death by 2015. The results have been mixed, since not all targets were achieved by 2015.<sup>(2)</sup>

The year 2015 was also decisive for the Millennium Development Goals (MDGs), a global partnership and development-funding programme of unprecedented scope, to which the UN member states committed in 2000. Of the eight goals to be reached by 2015, three were directly related to health: reducing child mortality (Goal 4), improving maternal health (Goal 5), and combating HIV/AIDS, malaria and other diseases (Goal 6).<sup>(3)</sup> Major progress has been achieved, but it varies by goal and region (WHO, 2015a; Stuckler et al., 2010). For example, Goal 6 has been reached because the incidence of HIV

(2) For figures on progress in reducing mortality, see the *World Mortality Report 2013* (United Nations, 2013).

(3) The other goals were to eradicate extreme poverty and hunger, achieve universal primary education, promote gender equality, ensure environmental sustainability and develop a global partnership for development.

infection, tuberculosis and malaria has fallen since 2000. However, the targets on under-five mortality (reduce by two-thirds between 1990 and 2015), and maternal mortality (reduce by three-quarters) were probably over-ambitious, sub-Saharan Africa, South-East Asia, the Caucasus and Central Asia fall far short of those goals. Although the MDG programme succeeded in mobilizing the international community, it has been criticized for using aggregate targets and indicators and neglecting internal inequalities within countries.

The issue of inequality in health has returned to the forefront since the work of the Commission on Social Determinants of Health (2005-2008) and, more recently, the 2030 Agenda for Sustainable Development adopted by the United Nations in September 2015. The 2030 Agenda comprises 17 Sustainable Development Goals (SDGs). The health goal (Goal 3) seeks “to ensure healthy lives and promote well-being for all at all ages” and is associated with 13 targets, nine of which are quantified. These include maternal mortality, under-five mortality (with a new interest in neonatal mortality), communicable diseases such as AIDS and tuberculosis, and a new focus on mortality resulting from non-communicable diseases, substance abuse, road accidents and pollution. The post-2015 global agenda puts more emphasis on reducing inequalities and ensuring that “no one is left behind”.<sup>(4)</sup> The push for more equality in health can be seen in the promotion of the concept of universal health coverage, which aims to ensure that everyone has access to affordable, high-quality essential health-care services (WHO, 2015a).

The preparation and monitoring of these programmes, the international mobilization against AIDS since the 1980s, the resurgence of diseases like tuberculosis and cholera, as well as considerable improvements in data sources in the past 30 years have led to an expansion of research on health and mortality and their determinants. Growing resources are now devoted to measuring inequalities in death and identifying the mechanisms behind them. A large share of the scientific literature on mortality inequality focuses on child mortality, which is well documented in the available surveys. Until recently, relatively few studies looked at adult mortality, beyond AIDS and maternal mortality.

### *Scope of analysis*

Drawing upon the literature and the most recent estimates, and on more detailed studies of ten selected countries, this article reviews mortality trends and mortality inequalities in low- and middle-income countries between 1990 and 2015. How has the mortality decline in the past 25 years affected mortality inequalities? Have disparities between countries increased, or on the contrary, are life expectancies converging? Have inequalities within countries narrowed or widened? Which sub-populations – by age, sex, social group and place of residence – have benefited the most from recent progress?

---

(4) For a detailed comparison of the content of the two agendas, see WHO (2015).

The first section of this article defines the geographical scope of the review and describes the conventional sources of child and adult mortality data, measurement difficulties and relative data quality, as well as the key variables used to analyse the individual determinants. The second section looks at changes in life expectancies by sex between 1990 and 2015 and the contribution of the different age groups to the progress achieved. The third section deals with the changing pattern of child mortality and the determinants of inequalities within countries. The fourth section is concerned with adult mortality, with a particular focus on maternal mortality and HIV/AIDS. The fifth section discusses mortality inequalities by cause and the new forms of the epidemiological transition. The article concludes with some suggestions for further research.

## I. Geographical scope, data and methods

### 1. Geographical scope

This article focuses on low- and middle-income countries, according to the World Bank definition of 2014 (see Footnote 1 for the classification of countries by income). Of the 134 countries in those categories, we excluded 25 countries with a population of below 1 million in 2015.<sup>(5)</sup>

The 109 countries covered have been divided into three groups:

Group 1: upper-middle-income countries (39 countries);

Group 2: lower-middle-income countries (40 countries);

Group 3: low-income countries (30 countries).

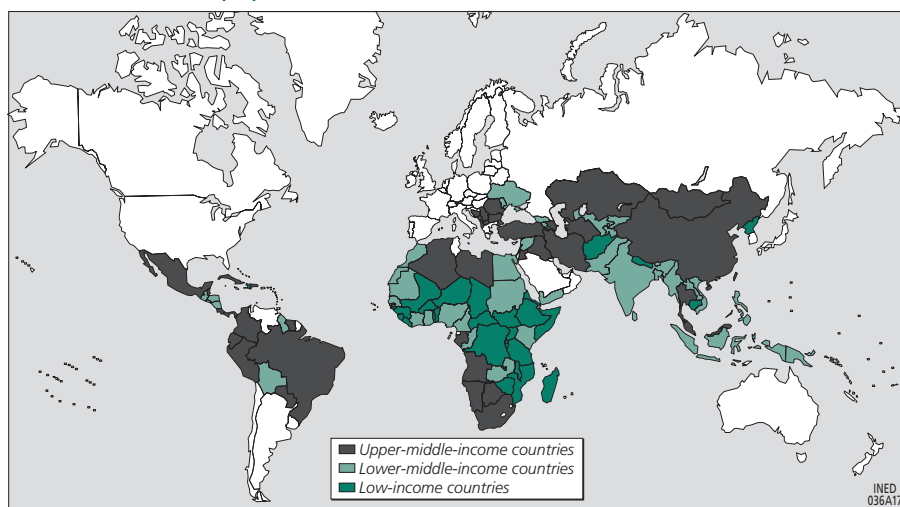
In our comparisons, we used the United Nations' classification of world regions: Northern Africa (6 countries), sub-Saharan Africa (42), East Asia (3), South-Central Asia (12), South-East Asia (9), Western Asia (10), Latin America (17) and Europe (9) (Figure 1).<sup>(6)</sup>

We analysed ten countries more closely to produce a more detailed study of internal social inequalities based mainly on individual-level survey data. We again divided these ten countries into three groups by income: Group 1 consisting of three upper-middle-income countries (China, Brazil, South Africa); Group 2 consisting of five lower-middle-income countries (Bolivia, Egypt, India, Indonesia and Nigeria); and Group 3 consisting of two low-income countries (Afghanistan and Burkina Faso). We selected these countries because they represent extremely diverse situations in economic, social, political and demographic terms. In 2015 the ten countries in our sample were home to more than 3.5 billion people, or 59% of the total population of low- and middle-income countries. Table 1 shows some of their recent socio-demographic characteristics.

(5) Aside from the small numbers of deaths due to their small populations, most of these countries do not have reliable civil registration systems and are generally less well documented. Kosovo was also excluded because the United Nations did not produce estimates for that country in the 2015 Revision.

(6) [https://esa.un.org/unpd/wpp/General/Files/Definition\\_of\\_Regions.pdf](https://esa.un.org/unpd/wpp/General/Files/Definition_of_Regions.pdf)

Figure 1. Low- and middle-income countries with a population of more than 1 million (109 countries)



Source: See Footnote 1.

Table 1. Selected characteristics of the three major socioeconomic country groups and the ten selected countries

Country	Group	Population (thousands) (2015)	Median age (2015)	Adult literacy rate (%) (2007-2012)	GNI per capita (USD) (2015)	Children per woman (TFR) (2015)	Percentage urban (2015)	Life expectancy (years) (2015)
South Africa	1	54,500	26	93	6,050	2.3	65	57
Brazil	1	207,800	31	90	9,850	1.8	86	75
China	1	1,376,000	37	95	7,820	1.6	56	76
Bolivia	2	10,700	24	91	3,080	2.9	69	69
Egypt	2	91,500	25	74	3,340	3.3	43	71
India	2	1,311,000	27	-	1,590	2.4	33	68
Indonesia	2	257,600	28	93	3,440	2.4	54	69
Nigeria	2	182,200	18	61	2,820	5.6	48	53
Afghanistan	3	32,500	18	-	630	4.7	27	61
Burkina Faso	3	18,100	17	29	660	5.4	30	59
Country category								
Upper-middle-income countries	1	2,390,100	34	94	8,186	1.9	64	74
Lower-middle-income countries	2	2,916,200	25	71	2,035	2.8	39	67
Low-income countries	3	638,700	18	63	620	4.7	31	61
World	-	7,349,500	30	84	10,433	2.5	34	71

**Sources:** World Population Prospects (2015 Revision) for population, median age, total fertility rate (TFR) and life expectancy in 2015 (values calculated by taking the average of the estimated values for the periods 2010-2015 and 2015-2020); WHO database (2016) for adult literacy; and World Bank database (<http://data.worldbank.org/>) for GNI per capita and percentage urban. The GNIs calculated using the Atlas method are expressed in current USD).

## 2. Data sources on mortality

Monitoring mortality trends and investigating mortality inequalities calls for high-quality health information systems that provide reliable, disaggregated data. Among the wide variety of available data sources on mortality, none is without limitations.

### *Civil registration and vital statistics systems*

When they provide death statistics by age, sex and cause, certified and classified in accordance with the WHO's International Classification of Diseases, civil registration systems are the only source, combined with a census, that allow continuous monitoring of mortality by age and cause of death. Of the 109 countries studied here, only 50 supply cause-of-death statistics to the World Health Organization (WHO, 2016). The data are only fully useable for 15 of those countries, where more than 90% of deaths are registered with an underlying cause. According to the WHO, in our sample of ten selected countries, only South Africa and Egypt register more than 90% of deaths and their causes, compared with less than 25% in China and India (for 2007-2013).<sup>(7)</sup>

### *Censuses*

Mortality – and consequently life expectancy – are estimated from answers to census questions about deaths by age that have occurred in the household in the previous 12 months, or about the survival of children and, in some cases, the survival of adults. Indirect demographic methods have been developed to compensate for the frequent under-reporting of deaths or to convert the percentage of surviving close relatives into survival probabilities. However, these methods are not ideal for measuring social inequalities because they rely on numerous assumptions, such as homogeneous quality of death reporting across the different social categories (Moultrie et al., 2013).

### *Retrospective surveys*

Retrospective surveys are the source most frequently used to estimate under-five mortality. Since the 1980s, most data have come from Demographic and Health Surveys (DHS), mainly funded by the United States, and UNICEF's Multiple Indicator Cluster Surveys (MICS).<sup>(8)</sup> These surveys are designed to permit comparative approaches across time and space because the questionnaires are standardized and the collection methodologies are almost identical. The information gathered from women aged 15-49 can be used to estimate under-five mortality, based on their birth histories that provide information on the

(7) These figures should be interpreted with caution because they are based on information submitted to the WHO by the countries themselves. For some countries, the completeness of registration data and the quality of cause-of-death statistics have been analysed in detail. The results of these analyses may differ from the WHO estimates (Franca et al., 2008).

(8) A total of more than 300 DHS surveys have been conducted in 90 countries since 1982; and 285 MICS surveys in 108 countries since 1995.



survival of children, and to estimate adult mortality, based on reported survival of parents and siblings (Masquelier et al., 2014a). Over the past 20 years, numerous studies on inequalities have been based on DHS data, dealing in particular with inequalities between men and women, between rural and urban areas and between ethnic groups, as well as by educational level and by standards of living. Caution is still required because some of the characteristics recorded at the time of the survey may have changed over time and thus skew the explanation for the differentials measured five to 15 years earlier (Bocquier et al., 2011; Lankoande, 2016).

### *Demographic surveillance systems*

There are around 40 demographic surveillance systems in 19 countries, often located in rural areas. A small population (between several hundred and several thousand households) is monitored in a targeted geographical area over a long period, so the data on mortality trends and causes of death are generally of high quality, but scope for studying mortality differentials is limited because the populations are fairly homogeneous in cultural and socioeconomic terms (INDEPTH, 2005). These systems closely monitor all changes in these communities and provide opportunities to conduct exploratory studies, on the impact of vaccination for example, or on the importance of less conventional determinants of mortality, such as the role of the family environment (Samuel and Hertrich, 2016).

## 3. Indicators and main determinants

For overall mortality, we used life expectancy at birth,<sup>(9)</sup> as estimated by the United Nations Population Division (United Nations, 2015), which provides some of the most reliable international figures. Mortality inequalities within countries (between the sexes, between different regions, and between urban and rural areas) were estimated for just three countries in our sample, namely Brazil, China and India, because they have official life tables of relatively good quality for several dates.

For child mortality by sex, we used the international estimates calculated in 2015 by the United Nations Inter-Agency Group for Child Mortality Estimation (IGME), which monitors progress in child survival (UN IGME, 2015). To analyse inequalities in the ten selected countries, we used DHS data from the past 20 years and studies based on these data. The indicators are usually of risks (probabilities) from birth to a specific age (neonatal mortality at ages 0-1 month, infant mortality at ages 0-1 year, and child mortality at ages 0-5 years). We also considered mortality at ages 1-4 years, the age group most sensitive to both health gains and health crises.

---

(9) Life expectancy at birth is the average number of years a person can expect to live if throughout his/her life she/he is exposed to the age-specific mortality risks of the year or period in question.

For adult mortality, we used the adult mortality risk for each sex (the probability of dying between ages 15 and 60 years) and the maternal mortality ratio (number of maternal deaths per 100,000 live births), again based on UN agency estimates (United Nations, 2015; WHO, UNICEF, UNFPA, World Bank, UN Population Division, 2015). We decided not to examine mortality at older ages because the relevant data are scarce and often of poor quality.

The Appendix Table shows the main mortality indicators for 1990 and 2015 estimated by the UN agencies for the 109 countries.

As in much of the literature, our analysis of within-country inequalities, conducted using individual-level DHS data, is based primarily on the variables available in most surveys: place of residence (urban or rural), education (none, primary, secondary or higher), and income.

Numerous indicators are used to measure social and health inequalities, and there is still some methodological debate in the literature on health (Regidor, 2004a; 2004b). An important distinction should be made between absolute inequalities, which can be measured, for example, by the absolute difference in child mortality rates between the most advantaged group and the most disadvantaged group, and relative inequalities, which are measured by the ratio between the two rates. We shall use both approaches here, based on simple indicators.<sup>(10)</sup>

#### 4. Relative data quality: caution still needed

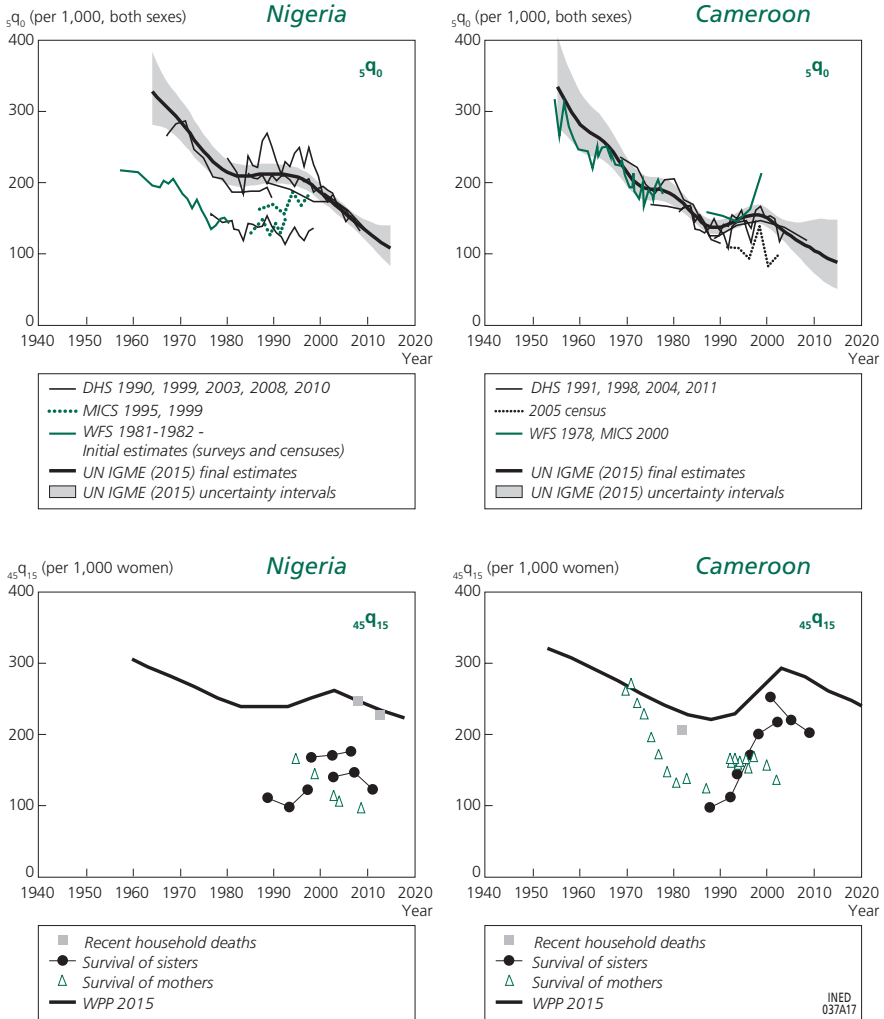
The data collected by surveys, censuses or civil registration must be of high quality to guarantee the accuracy of the levels, trends and differentials observed. This is particularly true for death, a tragic event that people generally prefer not to talk about. Reporting of deaths can therefore be distorted by inaccurate recall and time location. Caution and distance are always required for this type of data, especially when they are used to investigate inequalities, because reporting quality may vary across social groups.

As an illustration, Figure 2 shows different estimates of the risk of dying before age 5 and at ages 15-60 for two neighbouring Western African countries, Nigeria and Cameroon. In Nigeria, the surveys and censuses lead to very different – and in some cases implausible – estimates of child mortality levels and trends. Conversely, in Cameroon, the estimates are much more consistent, and provide a fairly accurate picture. To calculate a plausible, smoothed trend, the United Nations agencies start with estimates from surveys and censuses and then apply a statistical model to derive adjusted estimates (represented in Figure 2 by a bold line),<sup>(11)</sup> and uncertainty intervals (Alkema et al., 2014a).

(10) Other more sophisticated indicators exist, often requiring data that are not available for all countries.

(11) This line represents the final UN IGME estimates. They were calculated by combining the mortality levels derived from the various surveys and censuses by means of a statistical model that takes account of sampling errors and non-random errors in the different data sources (Alkema et al., 2014a).

Figure 2. Trends in probabilities of dying at ages 0-5 (per 1,000 births) and at ages 15-60 (per 1,000 women aged 15), according to various sources in Nigeria and Cameroon



Sources: UN IGME database for child mortality estimates (<http://childmortality.org/>), authors' calculations for adult mortality (based on DHS data in Nigeria and Cameroon, and censuses in Cameroon in 1976 and 1987); United Nations (2015).

In the absence of vital statistics, estimating adult mortality is more difficult, as Figure 2 illustrates. In Nigeria, the data on recent household deaths in the 2008 and 2013 DHS surveys produce fairly high adult mortality rates, of around 350 per 1,000 for women. The information gathered in the same surveys about the survival of sisters produces much lower rates, of around 215 per 1,000 (closer to the estimates derived from survival of parents). What is the real level of adult mortality in Nigeria? The UN Population Division gives an estimate

of 340 per 1,000 in 2010, which is hard to justify and has sparked controversy (Gerland et al., 2014; Kassebaum et al., 2014). Cameroon provides another illustration of the uncertainty surrounding adult mortality. According to data on the survival of mothers and sisters collected in surveys and censuses, adult mortality was around 200 per 1,000 in the 1980s, then rose to around 300 in the early 2000s. According to the United Nations (2015), it remained steady at around 315 between 1970 and 1995, then increased to 400 in about 2003. The estimates derived from surveys and censuses are certainly distorted by under-reporting of deaths, but to what extent?

## II. Life expectancy at birth: progress but persistent inequalities

### 1. Overview

Between 1990 and 2015, worldwide life expectancy rose from 64 to 71 years, increasing from 63 to 70 years in middle-income countries, and from 49 to 61 years in low-income countries (United Nations, 2015). All the major world regions recorded significant gains: from 49 to 58 years in sub-Saharan Africa, from 58 to 68 years in South-Central Asia, from 65 to 71 years in South-East Asia, from 68 to 75 years in Latin America, and from 70 to 77 years in East Asia. While absolute gains (6-8 years) are similar, inequalities between the major geographical regions remain very large. Sub-Saharan Africa lags more than 17 years behind Latin America and 10 years behind South Asia; Latin America has kept its lead of 3 or 4 years over South-East Asia, and its lag of 2 or 3 years behind East Asia. At this geographical scale, convergence between regions is still a very distant prospect.

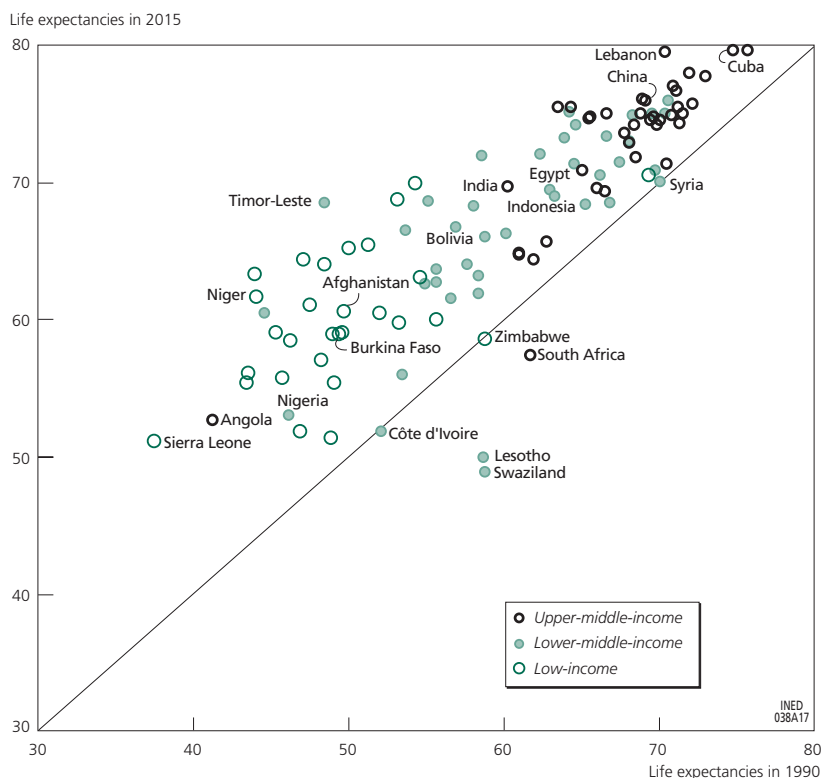
Figure 3 shows the trend in life expectancy (both sexes) in 108 low- and middle-income countries from 1990 to 2015.<sup>(12)</sup>

Life expectancy increased in the countries located above the diagonal line, but decreased or remained unchanged in those below or on the line. The further a country lies from the diagonal, the larger the changes in life expectancy between 1990 and 2015.

Aside from about ten countries lying below or close to the diagonal, life expectancy has improved almost everywhere, but highly unevenly, with gains ranging from 2 to 18 years between the extreme cases, although most countries have gained 6 or 7 years. Inequalities in between these countries were already high in 1990, with life expectancies ranging from 37 to 76 years, and were still high in 2015 (life expectancies from 49 to 80 years). The six countries where

(12) Since the United Nations release data by five-year periods, we used the average of the periods 1985-1990 and 1990-1995 to calculate 1990, and the average of the periods 2010-2015 and 2015-2020 (projections) to calculate 2015. All the other mortality indices centred on 1990 and 2015 were calculated in the same way (United Nations, 2015). We excluded Rwanda from the 109 countries in the initial selection because of the low life expectancy in 1990-1995 (23 years) resulting from the genocide of 1994, and the difficulty of estimating mortality for 1990 by performing the same interpolation.

Figure 3. Change in life expectancy at birth (both sexes) in 108 ranked countries from 1990 to 2015, by income level in 2015



Source: United Nations (2015).

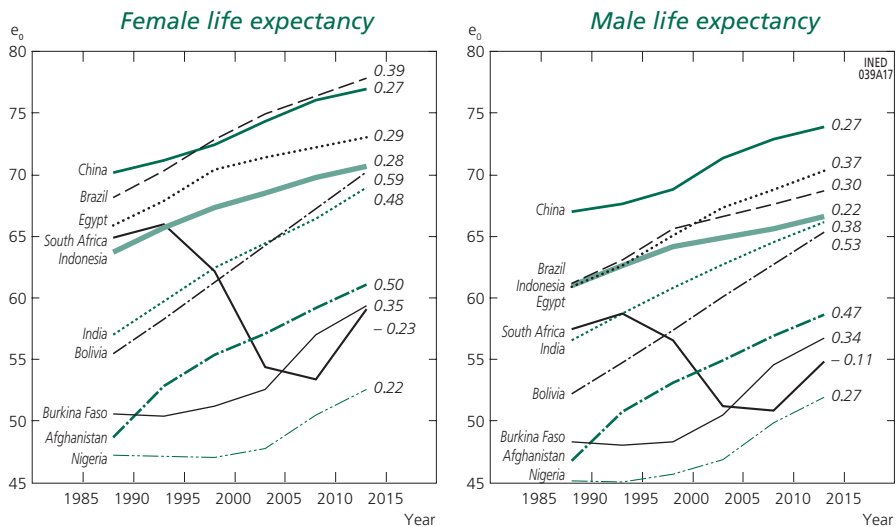
life expectancy stagnated or decreased between 1990 and 2015 were either severely impacted by HIV/AIDS over those 25 years (Lesotho, South Africa, Swaziland, Zimbabwe, and to a lesser extent, Côte d'Ivoire), or by war (Syria since 2011).

National income and life expectancy are linked (Figure 3); in 1990 as in 2015, most of the richer countries exhibited longer life expectancy, while most of those in the low-income group had by far the shortest life expectancies. The gap has narrowed, however: it is in the poorest countries that the improvement over those 25 years was the fastest, with average annual gains of 0.5 years and a total of 12 years over the period, compared with 0.28 years and 7 years for middle-income countries.

## 2. Changes in the ten selected countries

To refine the chronology and highlight the diversity of trends in life expectancy by sex for each five-year period, we will examine the case of the ten countries in our sample (Figure 4), based on UN data.

Figure 4. Trends in life expectancy at birth and average annual gain in 10 countries, by sex and period, from 1990 to 2015



**Note:** The values to the right of each curve represent the average annual increase in life expectancy over the 1990-2015 period.

**Source:** United Nations (2015).

These curves confirm and clarify several points:

- Inequalities between the ten countries are almost as high in 2015 as in 1990, for both men and women.
- The patterns are diverse, from a slowdown in the pace of improvement (e.g. China and Egypt in a recent years), to a steady uptrend (Bolivia), or an acceleration since the 2000s (Burkina Faso, Nigeria).
- The 2000s emerge as a turning point, especially 2005. The poorest countries posted the biggest gains in the years after 2005, which can be seen in the increase in average life expectancy in Burkina Faso and Nigeria. Average annual life expectancy gains in those countries rose from 4.7 months between 1990 and 2005 to almost 8 months between 2005 and 2015.
- AIDS has had a major impact in some countries: a clear illustration is South Africa, which lost 10 years of life expectancy between 1990 and 2005 (from 62 to 52 years), before a more recent upturn.<sup>(13)</sup>
- The life expectancy trends tend to favour women, whose annual gains are often higher than those of men.

### 3. Contributions of the different age groups to life expectancy gains

Progress in mortality inevitably varies by age. It depends on the level and causes of mortality, i.e. the stage of the epidemiological transition that a society

(13) See Tabutin and Schoumaker (2004) for historical data on mortality in sub-Saharan Africa.

has reached on a particular date (Section V). The population can be analysed by age to determine the respective contributions of the different age groups to changes in life expectancy over time (Arriaga, 1984).

Table 2 shows the contribution of the six main age groups to the (absolute) life expectancy gains recorded in the ten selected countries between 1990 and 2015. Excluding South Africa (where life expectancy fell by four years), the gains over the period range from 6 years (Indonesia) to 13 years (Bolivia). They vary considerably across countries, but with no apparent link to income levels. Unsurprisingly, a decrease in mortality at young ages has a particularly strong impact when initial life expectancy was low. In Nigeria, Burkina Faso and Egypt, the decrease in under-five mortality accounts for some 75% of the increase in average life expectancy, compared with 30%-40% in China and Brazil, whose life expectancy in 1990 was already over 65 years. The almost four-year drop in life expectancy in South Africa can be attributed to AIDS, especially at ages 15-50.

**Table 2. Absolute contribution of the different age groups to life expectancy gains/losses (both sexes) between 1990 and 2015**

Country	Group	Life expectancy			Contribution of the different age groups to life expectancy gains between 1990 and 2015					
		1990	2015	Change 1990-2015	0	1-4 yrs	5-14 yrs	15-49 yrs	50-79 yrs	80+ yrs
South Africa	1	61.7	57.4	-4.3	0.8	0.3	-0.8	-5.1	0.4	0.1
China	1	69.0	76.0	7.0	2.4	0.7	0.3	1.0	2.3	0.4
Brazil	1	65.4	74.7	9.4	2.4	0.3	0.2	1.8	4.0	0.8
Bolivia	2	55.1	68.7	13.5	3.7	2.2	0.7	2.6	3.5	0.8
Egypt	2	64.5	71.3	6.8	3.6	1.4	0.3	1.0	0.5	0.1
India	2	58.0	68.3	10.3	3.5	1.9	0.8	1.6	2.3	0.2
Indonesia	2	63.3	69.0	5.8	2.7	1.0	0.4	0.7	0.9	0.1
Nigeria	2	46.1	53.0	6.9	3.1	2.6	0.3	0.5	0.3	0.0
Afghanistan	3	49.7	60.7	11.0	3.6	2.2	0.8	3.0	1.3	0.1
Burkina Faso	3	49.4	59.0	9.6	2.8	4.0	0.6	1.5	0.7	0.0

*Source:* Authors' calculations based on Arriaga's method (1984) applied to United Nations data (2015).

#### 4. A universal but unequal female advantage

Historically, health and mortality gains have always coincided with a reduction in gender inequality; countries have gradually moved from similar male and female life expectancies to one where women have a significant advantage over men, although this varies across cultures and regions. Women's biological advantage at birth<sup>(14)</sup> should give women a higher life expectancy

(14) For more information on the origin of the female biological advantage, see, for example, Waldron (1998), Vallin (2005). We still are unable to measure precisely all the factors involved in that advantage.

than men, but the natural female advantage may later be undermined by discrimination in nutrition and healthcare and by the risks associated with pregnancy and childbirth. This can lead to excess female mortality at certain ages, which is sometimes called a “social” mortality differential (Tabutin, 1978). It is the level and ages of gender-specific excess mortality that determine the life expectancy differentials by sex: “the mortality difference between men and women is not only a matter of biological sex, but also of socially constructed sex, i.e. gender” (Vallin, 2005).

From the 1950s to the 1980s, the decades of the first major mortality declines in the South, life expectancy increased faster for women than for men, especially in the poorest countries, creating a growing female advantage (United Nations, 2013).

In 1990, on the macro-geographical level (Table 3), the female advantage was clearly visible in low- and middle-income countries, but varied by region (from 1.4 years in South Asia to 7.9 years in Europe) and level of development (from 2.5 years to 4.5 years). Since 1990, despite the overall improvement in life expectancy that should have favoured women (thanks partly to a decline in maternal mortality) and hence widened the gender gap, the differential has remained unchanged (around 6.3 years in Latin America and 3.9 years in North Africa) or even decreased (from 3.1 to 2.6 years in sub-Saharan Africa, and from 3.4 to 3.1 years in East Asia), excepting in South Asia,<sup>(15)</sup> where women are making up lost ground and regaining an advantage. In 2015, it was the poorest regions and the most fragile in terms of health that had the smallest gender differentials (2.6 years in sub-Saharan Africa, 3.0 years in South-Central Asia).

### *China, India and Brazil*

High excess female mortality is a longstanding phenomenon in China and India, contrary to Brazil. These three countries are among the best documented.<sup>(16)</sup>

In the twentieth century, India and China, like other countries in Asia (such as Vietnam and Pakistan), the Middle East and Northern Africa (such as Algeria), excess female mortality was high at young and adult ages; the female advantage in life expectancy was therefore very small and there was even a male advantage in some cases. These countries have continued to make significant gains in life expectancy since 1990, albeit at different rates and at a slightly slower pace overall than in the 1970s and 1980s. In the last 25 years, female life expectancy gains have strongly outpaced male gains (Table 4), with almost 9 years for women versus 6.8 years for men in China, and 10 years and

(15) Due to the frequent absence of reliable data, the mortality estimates by sex of the UN Population Division are constructed from models and assumptions. They should therefore be treated with caution, as Attané and Barbieri point out in relation to East Asia (2009).

(16) These three countries produce relatively reliable official life tables by sex and region, and sometimes by place of residence. This is not the case for Indonesia, where mortality statistics are of highly uncertain quality, requiring adjustments and the use of models (Soemantri and Afifa, 2016).



Table 3. Life expectancy at birth (years) by sex and female-male difference, 1990-2015, by region and income category

	1990				2015				Change in difference (F-M) 1990-2015
	Both sexes	Females	Males	Difference (F-M)	Both sexes	Females	Males	Difference (F-M)	
<b>Income categories</b>									
High-income	74.1	77.7	70.4	7.3	79.2	82.2	76.2	6.0	- 1.3
Upper middle-income	67.9	70.3	65.8	4.5	74.3	76.5	72.3	4.2	- 0.3
Lower middle-income	59.1	60.4	57.9	2.5	66.9	68.8	65.2	3.6	+1.1
Low-income	49.0	50.5	47.5	3.0	61.4	63.0	59.8	3.2	+0.2
<b>Regions (low- and middle-income countries only)</b>									
Northern Africa (6 countries)	64.0	65.9	62.1	3.8	71.3	73.3	69.3	3.9	+0.1
Sub-Saharan Africa (42)	49.7	51.3	48.1	3.1	58.7	60.0	57.4	2.6	- 0.5
East Asia (3)	69.1	70.7	67.4	3.4	76.0	77.5	74.4	3.1	- 0.3
South-Central Asia (12)	58.8	59.5	58.1	1.4	68.7	70.2	67.2	3.0	+1.6
South-East Asia (9)	65.1	67.5	62.7	4.9	70.7	73.5	67.8	5.7	+0.8
Western Asia (10)	65.3	68.3	62.3	6.0	72.1	75.1	69.1	6.0	0
Latin America (17)	67.2	70.5	63.9	6.4	74.9	78.1	71.8	6.2	- 0.2
Europe (9)	70.0	73.9	66.0	7.9	72.8	77.0	68.7	8.4	+0.5
World	64.1	66.4	61.8	4.6	71.1	73.3	68.9	4.4	- 0.2
<b>Note:</b> The regional averages were obtained by weighting the life expectancies by the populations of each sex.									
<b>Source:</b> United Nations (2015).									

7.5 years, respectively, in India. Chinese women can now expect to live for close to 80 years,<sup>(17)</sup> Indian women almost 70.

These rapid improvements in female life expectancy, which have occurred in most age groups (Zhao et al., 2016), have widened the gender gap in life expectancy at the country level (Table 4): between 1990 and 2015, the female advantage increased from 3.7 years to 5.8 years in China, while the trend in India went from equality to a three-year female advantage. However, these differentials are smaller than those observed in Europe when life expectancy was at equivalent levels, or in Latin America today. This is clearly illustrated by the example of Brazil, which has also recorded large life expectancy gains, but of the same number of years for both sexes (around 8 years). When average life expectancy was 60 years (in around 1975), Brazilian women had a 5.5 year advantage over men, which is almost the same differential as in China today, some 40 years later, where average life expectancy is 76 years.

A comparison of the three countries confirms the gradual emergence of a female life expectancy advantage, including in India, which lagged for many

**Table 4. Life expectancy at birth (years) by sex from 1970 to the 2010s in China, India and Brazil**

Country	Overall	Females	Males	Difference (F-M)
<b>China</b>				
1970 <sup>(a)</sup>	58.2	60.2	56.5	+3.7
1980 <sup>(a)</sup>	66.3	68.3	65.0	+3.3
1990	68.6	70.5	66.8	+3.7
2000	71.4	73.3	69.6	+3.7
2015	76.3	79.4	73.6	+5.8
Increase since 1990	7.7	8.9	6.8	-
<b>India</b>				
1970-1975	49.0	49.0	50.5	- 1.5
1988-1992	58.7	59.0	58.6	+0.4
2000-2004	63.9	65.2	62.8	+2.4
2006-2010	66.1	67.7	64.6	+3.1
2010-2015 <sup>(a)</sup>	67.5	69.0	66.1	+2.9
Increase since 1990	8.8	10.0	7.5	-
<b>Brazil</b>				
1970 <sup>(a)</sup>	59.1	61.5	56.5	+5.0
1980	62.6	65.7	59.6	+6.1
1991	67.0	70.9	63.2	+7.7
2000	70.4	74.3	66.7	+7.6
2013	74.9	78.6	71.3	+7.3
Increase since 1991	7.9	7.7	8.1	-
<b>Sources:</b> Recent official data for each of the countries, consulted in 2016. China: National Bureau of Statistics of China; India: Central Statistical Office; Brazil: Instituto Brasileiro de Geographia e Estatistica (IBGE), except (a): United Nations (2015).				

(17) By comparison, in 2015, women had an average life expectancy of 82.2 years in the United States, 83.2 years in Belgium, 85 years in France and 87.3 years in Japan (the world record).

years. It also shows that the gender gap at a given time is not directly linked to the overall mortality level. Each region, and even each country within each region, has its own history in this respect, which is influenced by the health gains achieved but also by the changing norms and cultures that govern gender relations.

But are the same sex differentials in life expectancy observed at a smaller geographical scale? Have all the provinces or regions of these large countries moved in the same direction, and at the same speed? Thanks to the wealth of data available in India,<sup>(18)</sup> we can review mortality trends in 17 Indian states between 1970 and 2010. Saikia (2016) highlights the diversity of situations and trends. Some 35 years ago, in all the states except Kerala and Maharashtra, women had lower life expectancy than men, with a particularly large gender gap in the east and north. By 1990, the situations were more varied. Nationally, India attained gender equality in life expectancy, but excess female mortality persisted in almost half of the states, particularly in rural areas, until around 2002 (Canudas et al., 2015; Saikia et al., 2010). By the late 2000s, the trend had reversed, and all states (bar one, in the north-east) exhibited a female life expectancy advantage. Progress was variable, however, with the female advantage in 2008 ranging from 0.7 years in Bihar to 5.4 years in Kerala. Of course, analysis at a finer district level would reveal even more heterogeneity and would identify excess female mortality in a number of localities.

The scenario is somewhat different in China, where, by 1990, women already lived longer than men in all provinces. The female advantage<sup>(19)</sup> ranged from 2.7 years in Inner Mongolia (where life expectancy was 66 years) to 4.3 years in Shanghai (life expectancy of 75 years). Two decades later, in 2010, the female advantage had increased everywhere, but without the strong divergence between states found in India: it ranged from 3.0 years in the provinces where it was lowest to 5.4 years in those where it was highest. The female advantage in China is especially high in the cities because of the large gender gap in mortality from cancers and circulatory and respiratory diseases (Le et al., 2015).

In Brazil, the female advantage, already high in 1991 (7.7 years at country level) remained stable until 2004 (at 7.6 years) before falling slightly in 2010 (to 7.1 years and an average life expectancy of 74 years).<sup>(20)</sup> But the slight dip at the country level is the result of two contradictory trends: a decrease in the wealthiest, most urbanized states and an increase in the three poorest ones. As in China, the lack of data on causes of death by region means that the epidemiological origin of these contrasting developments cannot be determined.

(18) Thanks to the relatively good quality of the mortality data in the Sample Registration System (SRS) since 1969-1970, which can be used to construct complete life tables by place of residence and by sex for each of the large Indian states.

(19) The calculations are based on the official tables published by the Central Bureau of Statistics of China in its Statistical Yearbook for 2013.

(20) Calculated using basic data (not shown here) from Oliveira et al. (2005) and IBGE (2010).

## 5. Persistent regional inequalities

Very few countries in the South have reliable life tables for several dates by region or place of residence, and, to our knowledge, almost none by educational level, social group or ethnicity. Yet data of this kind are needed to obtain an accurate picture of changes in life expectancy inequalities within a country.

China, Brazil and India produce regional life tables. Table 5 shows the official regional life expectancies published for specific years: 1990, 2000 and 2010 for China and Brazil, 1997 and 2008 for India. These vast countries consist of many large administrative entities (provinces in China, states in India and Brazil). We therefore selected six extreme entities in 1990: the three with the highest life expectancies, and the three with the lowest.

Life expectancy differentials by region narrowed between 1990 and 2010, but only slightly at the macro-geographical level, particularly in China and India, where the gap between the extreme entities decreased from approximately 10 years in 1990 and 2000 to 9 years in 2010 (Table 5).<sup>(21)</sup> In Brazil, the biggest gap between regions narrowed from 10 years in 1991 to 7.5 years in 2010. The regions lagging farthest behind progressed everywhere, especially in Brazil, still one of the most unequal countries.<sup>(22)</sup>

Rural-urban inequalities (Table 5) appear to have narrowed in India, from an urban advantage of 6.1 years in 1997 to 4.7 years in 2007. This national average masks differences at a finer level. In the most developed Indian states with higher life expectancies, the urban advantage (data not shown here), which was small in 1997, increased in the 2000s from 1.4 to 3.4 years in Punjab and from 2.6 to 4.4 years in Himachal Pradesh, but not in Kerala, which maintained near equality in life expectancies between urban and rural areas.<sup>(23)</sup> Conversely, in the three states with the lowest life expectancies, the large rural disadvantage in 1997 improved slightly by 2008, narrowing from 9 to 7.8 years in Assam and from 5.8 to 4.6 years in Odisha. It is hard to say more without a detailed analysis of the urban and rural environments and of the health policies implemented in each state.

To sum up, the mortality differentials between states or provinces have decreased in India, China and Brazil. However, measured at a macro-geographical level, they mask a diversity of specific situations and trends at sub-national level, and between urban and rural environments.

(21) Unsurprisingly, mortality inequalities have increased everywhere at a finer geographical level. For example, in China, the extreme differentials between prefectures were as high as 23 years in 2000, compared with 10-11 years at the provincial level (Guilmoto, 2016).

(22) Even if inequalities seem to have decreased in the past 20 years, Brazil, alongside South Africa, remains the most socio-economically unequal country in the five-country BRICS group (Brazil, Russia, India, China and South Africa) (Mujica et al., 2014).

(23) Kerala is an exception in today's world. For many years it has topped the rankings for social, educational and health indicators.

**Table 5. Regional inequalities in life expectancy (both sexes) in China, India and Brazil since 1990**

China	1990	2000	2010	Absolute change 1990-2010
Extreme life expectancies (provinces)				
Shanghai	74.9	78.1	80.3	+5.4
Beijing	72.9	76.1	80.2	+7.3
Tianjin	72.3	74.9	78.9	+6.6
...	...	...	...	...
Yunnan	63.5	65.5	69.5	+6.0
Mongolia	65.7	69.9	74.4	+8.2
Tibet	59.6	64.4	68.2	+8.7
Overall	68.6	71.4	74.8	+6.2
Average differentials between extreme groups	10.4	10.2	9.3	

India	1995-1999	2006-2010	Absolute change 1997-2008
Extreme life expectancies (states)			
Kerala	71.7	74.2	+2.5
Pendjab	66.4	69.3	+3.1
Himachal Pradesh	66.2	70.0	+3.8
...	...	...	...
Assam	57.3	61.9	+4.6
Odisha	58.0	63.0	+5.0
Uttar Pradesh	59.1	62.7	+3.6
Urban	66.4	69.6	+3.2
Rural	60.3	64.9	+4.6
Overall	61.5	66.1	+4.6
Average differentials between extreme groups	10.0	8.7	

Brazil	1991	2000	2010	Absolute change 1997-2008
Extreme life expectancies (states)				
Rio Grande do Sul	71.1	73.1	75.7	+4.6
Santa Catarina	70.7	73.5	76.8	+6.1
Sao Paulo	69.5	72.2	76.0	+6.5
...	...	...	...	...
Maranhao	62.1	64.8	68.7	+6.6
Pernambuco	60.7	65.5	69.4	+8.7
Alagoas	59.7	63.8	68.0	+8.3
Overall	67.0	70.4	73.8	+6.8
Average differentials between extreme groups	9.6	8.2	7.5	

**Sources:** Recent official data for each country, consulted in June 2016. China: National Bureau of Statistics of China; India: Central Statistical Office; Brazil: Instituto Brasileiro de Geographia e Estatistica (IBGE).

### III. Child mortality has halved since 1990, but large inequalities persist

Under-five mortality is by far the best known component of mortality and the best documented in the literature, in terms of levels, trends and determinants, thanks to the vast quantities of data collected from mothers over the past 30 years through DHS and MICS surveys.<sup>(24)</sup> Moreover, under-five mortality is still considered to be one of the best indicators of social development and health inequalities. Given its persistently high levels in the 1990s and 2000s, and its impact on life expectancy, under-five mortality has received considerable attention in action programmes. Reducing under-five mortality was one of the key Millennium Development Goals (MDG 4)<sup>(25)</sup> and remains one of the Sustainable Development Goals for 2015-2030.<sup>(26)</sup> In the 2000s and 2010s, under-five mortality was analysed in numerous publications and several major reviews were devoted to the question (Houweling and Kunst, 2010; United Nations, 2013; UN IGME, 2015).

Owing to the differences in mortality levels, causes of death and risk factors during the period between birth and five years, we distinguish between neonatal mortality (first 28 days of life), infant mortality (before 12 months), child mortality (between 1 and 5 years) and under-five mortality (birth to 5 years). We shall start by examining the main global trends between 1990 and 2015, before looking more closely at the global inequalities between the sexes and between social groups, and in particular in six of the ten countries in our sample that have DHS data for several dates.

#### 1. A large overall decrease in under-five mortality over the past 25 years

Recent studies unanimously conclude that under-five mortality has fallen sharply everywhere since 1990, but with strong disparities. Table 6, constructed from research by the UN IGME (2015), presents an overview of the changes between 1990 and 2015 in low- and middle-income countries.

##### *Mortality in the first five years of life*

Under-five mortality has fallen significantly everywhere, whatever the base level, which was generally very high in 1990, with reductions ranging from

(24) There are also regional programmes specific to the Arab world, similar in content to the DHS surveys on health and child mortality: PAPCHILD (Pan Arab Project for Child Development, 10 countries, 1989-1996), PAPFAM (Pan Arab Project for Family Health, 7 countries, 2000s), and two successive programmes for the six Gulf states between 1989 and 1998.

(25) The MDG target was a two-thirds reduction between 1990 and 2015. Only 24 low- or lower-middle-income countries achieved the target by 2015.

(26) The SDG target is to reduce neonatal mortality in all countries to below 12 deaths per 1,000 live births, and under-five mortality to below 25 deaths per 1,000 live births.

55% to 65% by income group, and from 54% (sub-Saharan Africa) to 79% (East Asia) by region (Table 6). Globally, the mortality rate and the total number of deaths before age five have halved in 25 years. According to the data from UN IGME (2015), in the 109 low- and middle-income countries, 5.8 million children died before their fifth birthday in 2015, compared with 12.5 million in 1990. With mortality at young ages almost completely under control in the world's richest nations, 98% of under-five deaths are now concentrated in these countries.

**Table 6. Risks of death at ages 0-1 and 0-5 between 1990 and 2015, by region and income group**

	Risk of death at age 0-1 (per 1,000)			Risk of death at ages 0-5 (per 1,000)		
	1990	2015	Relative decrease (%)	1990	2015	Relative decrease (%)
<b>By country category</b>						
High-income	13	6	-55	15	7	-56
Upper-middle-income	43	15	-64	56	20	-65
Lower-middle-income	83	40	-51	119	53	-55
Low-income	113	53	-53	187	76	-59
<b>By region (low- and middle-income countries only)</b>						
Northern Africa (6)	60	27	-55	82	35	-57
Sub-Saharan Africa (42)	109	57	-48	182	84	-54
East Asia (3)	42	9	-77	54	11	-79
South-Central Asia (12)	88	40	-54	123	51	-59
South-East Asia (9)	53	22	-58	73	27	-62
Western Asia (10)	54	21	-61	71	25	-65
Latin America (17)	46	16	-66	59	19	-68
Europe (9)	22	8	-64	26	9	-65
World	63	32	-49	91	43	-53
<i>Note:</i> The regional averages or averages by income group were calculated by weighting the risks of death by the number of births in the same year (WPP 2015).						
<i>Source:</i> UN IGME (2015) and authors' calculations.						

Sub-Saharan Africa, where the majority of the poorest countries are located and where health infrastructure is the weakest, had the world's highest base levels in 1990. It too has seen substantial improvements, with a reduction in under-five mortality from 182 deaths per 1,000 births in 1990 to 84 in 2015, and in infant mortality from 109 deaths per 1,000 births in 1990 to 57 in 2015. However, sub-Saharan Africa is still by far the region with the highest under-five mortality risk: a newborn in sub-Saharan Africa is eight times more likely to die before age five than in China, and almost twice as likely as in India.

It is at ages 1 to 5 (child mortality) – the ages most responsive to social and health progress (vaccination, nutrition, etc.) but also to health crises – that the sharpest decreases in mortality have been achieved, ranging from a 65% reduction in sub-Saharan and Northern Africa to an 84% reduction in East Asia.<sup>(27)</sup> In the first month of life (neonatal mortality) – a vulnerable age traditionally less responsive to interventions owing to the nature of the risks and the cost of treatments – mortality reductions have been slower and more uneven (UN IGME, 2015), ranging from a decrease of 38% in sub-Saharan Africa to 81% in East Asia, and from 45% in low-income countries to 67% in upper-middle-income countries. These differences by age have gradually led to a concentration of under-five mortality in the first few weeks or months of life. Progress is very advanced in Latin America, East and South-East Asia, where mortality between two or three months and five years is now very low.

While overall progress has been substantial, the inequalities between world regions did not diminish between 1990 and 2015; in fact, they even increased. Across the different country income groups (excluding high-income countries), the under-five mortality ratio between the extreme groups widened from 3.3 in 1990 to 3.8 in 2015 (Table 6). Between the extreme regions it increased from 7 to 9.3. The direction of change was the same for infant mortality, and even more unfavourable for child mortality (ages 1-5).

An encouraging development is the faster pace of change in the 2000s, especially from 2005 onwards (UN IGME, 2015). On average, under-five mortality fell by 4.3% per year in low- and middle-income countries between 2005 and 2015, compared with 3.2% per year between 1990 and 2005. In some 20 countries, including some of the poorest, among them Cambodia, Kenya, Senegal, Burkina Faso and Mexico, the pace of mortality reduction doubled between the two periods. The recent acceleration is particularly evident in sub-Saharan Africa, thanks to programmes to prevent mother-to-child transmission of HIV and the distribution of anti-retroviral drugs in the countries severely affected by AIDS (Ndirangu et al., 2012; UNAIDS, 2015). Elsewhere, the progress was achieved mainly through renewed efforts to improve immunization coverage, sanitation, access to safe drinking water, and use of insecticide-treated mosquito nets to combat malaria. For example, coverage of the first dose of the measles vaccine – an effective, inexpensive method of immunization – rose from 57% in 1990 to 73% in 2015 in sub-Saharan Africa (World Bank, 2016), a faster increase than in the other regions. Sub-Saharan Africa also recorded substantial progress in access to safe drinking water, with an increase from 47% to 68% in the percentage of the population using an improved source of drinking water in the past 25 years (World Bank, 2016). Last, it is estimated that by 2015, 68% of children under five in the region were

(27) The data are not shown here but can be calculated from the risks of death at ages 0-1 and 0-5 shown in Table 6.

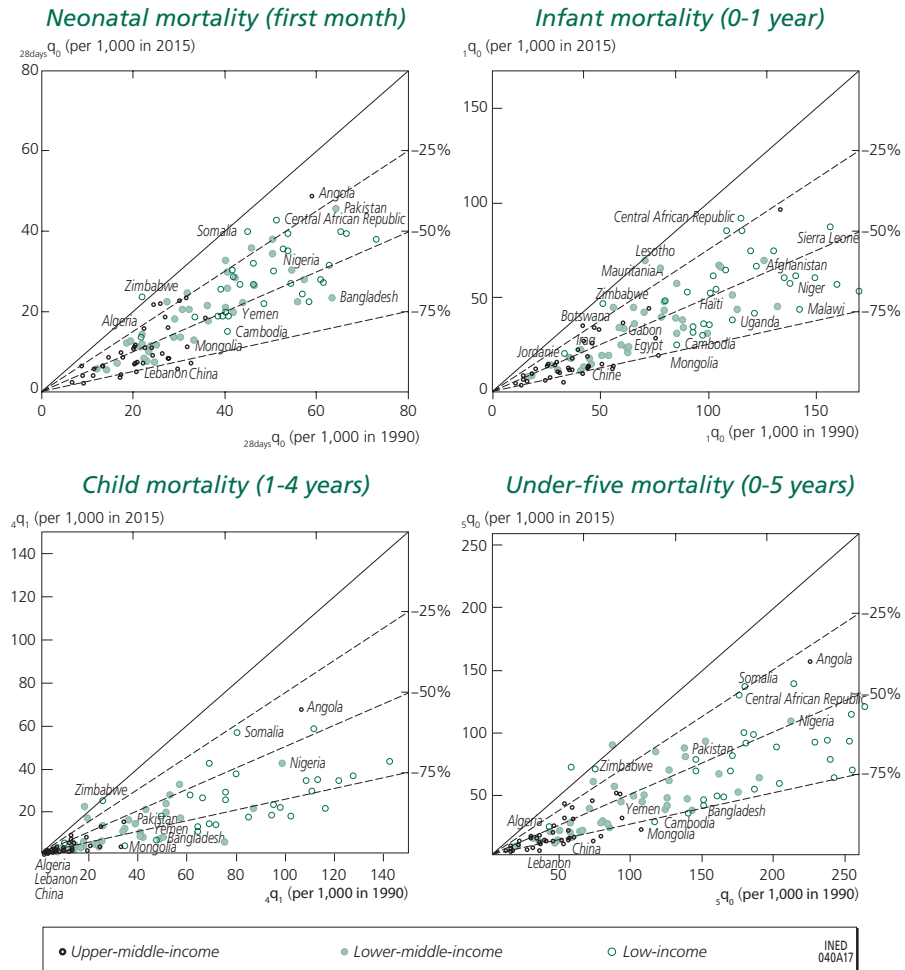


sleeping under insecticide-treated mosquito nets, compared with only 2% in 2000 (WHO, 2015b).

## 2. Considerable progress, but persistent inequalities between countries

Figure 5 illustrates the diversity of trends and situations at a finer geographical level – that of individual countries. It shows mortality levels (neonatal, infant, child and total under-five) in the 109 countries in 1990 and

Figure 5. Neonatal, infant, child and under-five mortality between 1990 and 2015 in the 109 low- and middle-income countries



**Note:** The dotted lines indicate the rates of decline (%) between 1990 and 2015. Under-five mortality in Niger and Sierra Leone is not shown because of the very high rates in 1990 (328 and 264 per 1,000 live births, respectively). Likewise for child mortality in Niger in 1990 (220 per 1,000 births).

Source: UN IGME (2015).

2015, and the speed of decline (the dotted lines represent relative declines of 25%, 50% and 75%).

As observed throughout history, it confirms that the slowest average decline is that of neonatal mortality, occurring during the first 28 days of life. Some of the poorest countries saw a decrease of less than 25%, and in many others it fell by between 25% and 50%. Neonatal mortality now hovers around 15 deaths per 1,000 live births in many countries, down from 25-30 around 25 years ago. As child mortality has fallen (especially through better control of infectious diseases), this age group accounts for an increasing share of deaths. In the 109 countries studied, the percentage of under-five deaths occurring in the first month of life rose from 40% in 1990 to 45% in 2015. The lower the overall mortality, the higher the percentage of neonatal deaths in the total: from 36% in low-income high-mortality countries to 49% in middle-income, lower mortality countries. Infant mortality, i.e. deaths at ages 0-12 months (Figure 5), is already declining more strongly on average: few countries reported reductions of less than 25%, and the vast majority (including 14 low-income countries) achieved reductions of between 50% and 75% in this age group.

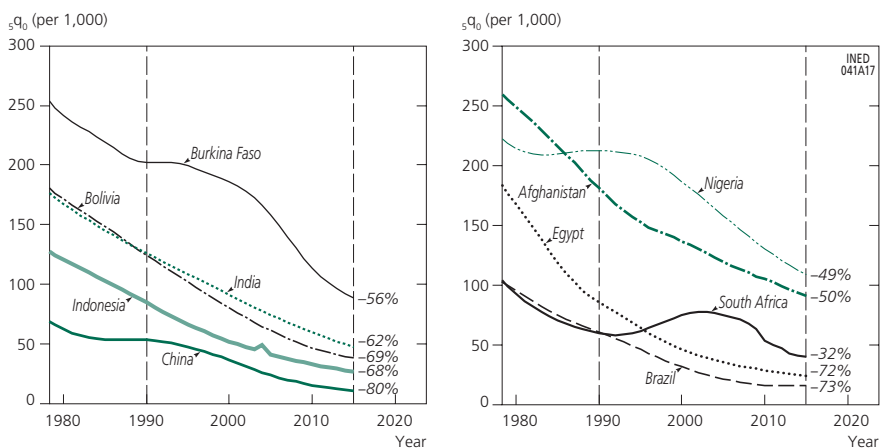
Overall, inequalities between countries are decreasing. A large percentage of countries now have infant mortality of between 10 and 60 per 1,000 live births, compared with between 15 and 150 in 1990. Only in around 15 countries – including Afghanistan, Somalia, Pakistan and Democratic Republic of Congo – infant mortality is still above 60 per 1,000 births. Lastly, it is between one and five years of age (child mortality) that the steepest declines have been observed almost everywhere, with reductions of 75% or more in most countries, excepting a few outliers, notably Zimbabwe and Central African Republic due to AIDS. Bangladesh, Egypt and Mongolia, among others, are close to the situation in the most advanced countries.

### 3. Diverse patterns by country over the past 25 years

A comparison of mortality levels at two widely spaced dates may fail to show the diversity of trajectories, disruptions or trend reversals. Figure 6 broadens the perspective by mapping the annual trends of under-five mortality in the ten selected countries.

First of all, the figure above confirms the extremely high level of under-five mortality in the late 1970s, ranging from 105 deaths per 1,000 live births (Brazil, South Africa) to 250 (Burkina Faso and Afghanistan), if we leave out China (which already had a low rate). It also shows that the improvement since 1990 fits into a longer process, which, for some countries, began in the 1960s or 1970s (estimates not shown here). It highlights the very different speeds of decline in the ten countries between 1990 and 2015 (reductions of 50% in Nigeria and Afghanistan, more than 70% in Egypt and Brazil, and 80% in China). Excluding South Africa (severely affected by AIDS), the improvement was greater in countries with the lowest mortality in 1990. The diversity of

Figure 6. Annual trends in under-five mortality in the 10 selected countries



**Note:** The values at the end of the curves indicate the percentage decrease in mortality between 1990 and 2015 in each country.

**Source:** UN IGME (2015).

situations in 1990 was still visible in 2015, but at other levels; if China is excluded, the absolute differential between extreme countries fell (from 152 to 93 points), but the relative differentials increased, with a ratio between extremes that rose from 3.3 to 6.5. We also see very varied trajectories, for example, the slowdown in progress in Burkina Faso in the late 1980s followed by a return to improvement in the early 2000s; the late start to improvement in Nigeria around 1995, and the significant slowdowns in progress in Egypt and Brazil in recent years after major gains. Last, the figure reveals the impact on under-five mortality of natural disasters (the tsunami in Indonesia in 2004) and major health crises (AIDS for almost 20 years in South Africa, because of mother-to-child HIV transmission).

Sex discrimination and socioeconomic and residential inequalities in early life, and their evolution over time, are longstanding issues of concern. In addition to studying the literature, we analysed data from two DHS surveys conducted some 15 years apart in six of the ten selected countries (Bolivia, Burkina Faso, Egypt, India, Indonesia and Nigeria) in order to investigate these inequalities by place of residence, mother's educational level and household income.

#### 4. Excess mortality of little girls: change and resistance

The gender differences in early childhood mortality<sup>(28)</sup> – a topic of concern for many years in the literature – are determined by both biological and socio-cultural factors. In terms of biology, the facts are fairly well established (Vallin,

(28) Taking account of data availability in these countries (usually survey data), like most researchers, we focus on ages 0-5 years. In their historical exploration (1750-1930) of western countries, Tabutin and Willems (1995) encompassed childhood and adolescence, from 0 to 20 years.

2005; Waldron, 1998): boys are generally less resistant than girls, and more vulnerable to various congenital and perinatal diseases.<sup>(29)</sup> In the epidemiological transition, the share of deaths from infectious and parasitic causes decreases, while that of deaths from perinatal and congenital causes, which affect boys more, increases. This leads to “biological” excess male mortality, which increases as overall mortality declines. Excess male infant mortality across the world is thus almost universal and increasing.

Conversely, after the first year of life, the situation is less clear. Between the ages of two and five years, boys often have more freedom and spend more time outside the home, and may therefore be more exposed to the various risks of infection and injury.<sup>(30)</sup> Disadvantages are also observed for little girls at those ages, which tend to be attributed to exogenous – environmental or socio-cultural – factors, taking the form of differential treatment of girl children (in terms of attention, food, medical care, etc.). In a still recent past, the expected biological excess mortality of boys was frequently more than offset by a “social” excess mortality of girls between ages one and five. In the 1970s and 1980s, around two in three developing countries exhibited high excess mortality of girls aged between one and five, which in some countries began in the first months of life, during the post-neonatal phase (Tabutin and Willems, 1995; United Nations, 1998).

### *Excess mortality of boys is increasing worldwide*

Most of the recent reviews of global trends in child mortality differentials by sex (Alkema et al., 2014b; United Nations, 2011; Sawyer, 2012) analyse changes in the previous 20 or 30 years, particularly in developing countries and regions, using the most reliable available estimates on as many countries as possible. Gender inequalities at the different ages (0-1, 1-4 years and 0-5 years) are often measured by the sex ratio of mortality, expressed as a percentage (number of male deaths for every 100 female deaths). A figure above 100 indicates excess male mortality, while a figure below 100 indicates excess female mortality (Figure 7). According to Hill and Upchurch’s model (1995),<sup>(31)</sup> when under-five mortality is around 50 per 1,000 live births (the current level in many Southern countries), we should observe roughly 125 male deaths at these ages per 100 female deaths in the absence of discrimination (the ratio should be around 128 below 12 months, and around 117 between one and four years). The sex ratio of mortality tends to increase as mortality rates fall, especially between the ages of one and four years.

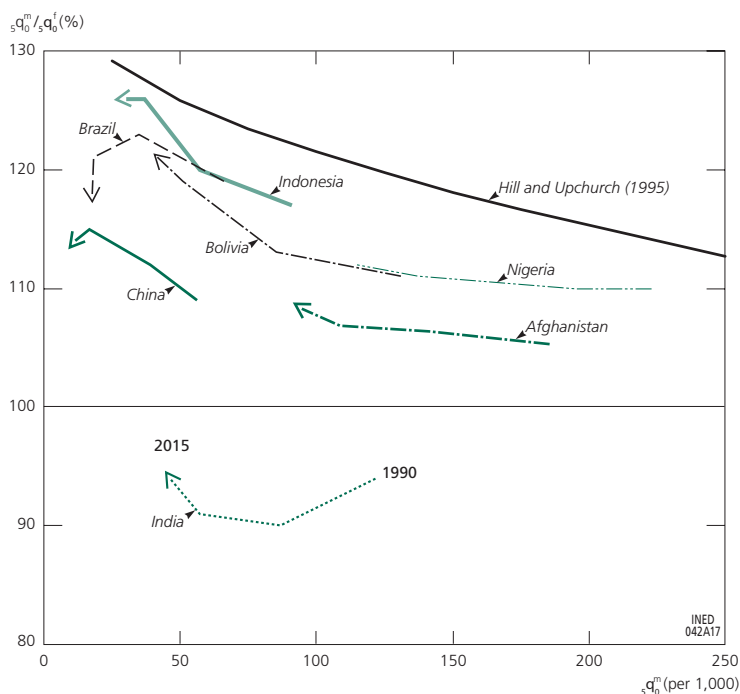
There have been huge changes in a majority of countries but these are not yet universal. On average, across 83 countries, excess male deaths below age

(29) These include trauma and asphyxia at birth, prematurity, congenital diseases, and respiratory and intestinal infections.

(30) Moreover, at these ages, girls lose some of their advantage against certain infections, such as measles (Garenne and Lafon, 1998).

(31) Model constructed from data for industrialized countries.

Figure 7. Under-five male mortality rates and sex ratios of mortality in seven countries, from 1990 to 2015



Source: UN IGME (2015). For a similar representation by major world regions, see Sawyer (2012).

five have increased, with a sex ratio of mortality that rose from 111 in the 1970s to 119 in the 2000s (United Nations, 2011). In line with Hill and Upchurch's model (1995), the ratio increased more for child mortality (one to four years) than for infant mortality (below 12 months). However, if we weight the average sex ratios of mortality at national level by the number of births in the country, the trend is reversed: the under-five mortality sex ratio fell from 103 in the 1970s (as opposed to 111) to 99 (as opposed to 119) in the 2000s, because of the enormous impact of China and India, which were exceptions to the global trend over that period (Figure 7).

Excess male infant mortality, which has increased slightly or remained stable since the 1990s, is now observed almost everywhere, with the noteworthy exception of China, even in the 2000s. Excluding China, it ranges from 16% to 24% between the major world regions.

In most regions (excluding China and India), the female disadvantage at ages 1-4 is narrowing, although it has not reached what it should be, given the current levels of mortality and the reductions achieved. Between the 1980s and the 2000s, the average regional mortality sex ratio at ages 1-4 years increased from 94 to 102 in Northern Africa and Western Asia, from 103 to 112 in East and South-East Asia (but only from 94 to 101 if China is included), from 81

to just 99 in South Asia (but from 77 to 69 if India is included), and from 106 to 113 in Latin America.

Here again, regional averages mask the diversity of socio-cultural situations and contexts at country level. With the possible exception of Latin America, no region in the world has been, or is, totally exempt from a preference for boys, which gives rise to discriminatory behaviours against girls that adversely affect their health. This is clearly the case in almost all countries of Northern Africa and the Middle East, where, from Morocco to Turkey, excess female mortality between one and five years is a longstanding phenomenon,<sup>(32)</sup> regardless of the wealth and overall mortality rate in each country (Tabutin et al., 2007). On average, excess mortality of girls is decreasing and, in some cases, has even disappeared (Alkema et al., 2014b), but at different speeds in different countries. The case of sub-Saharan Africa, a vast, highly diverse region long believed to be untouched by this problem, is worth a closer look. The DHS/MICS surveys in the 1980s and 1990s revealed widespread excess male infant mortality, but also found excess mortality of girls between the ages of one and five years (Tabutin et al., 2007). In the 1990s, these inequalities did not fit a precise geography; no link was found with the degree of Islamization of societies, nor with the level of social and health development of the countries concerned (Tabutin et al., 2007). According to Alkema et al. (2014b), excess male mortality between one and five years was low in sub-Saharan Africa in 2012 (2%), and practically unchanged since 1990.

### *The atypical histories and situations of India and China*

The social and health status of girls is a longstanding issue of concern in many countries of South and East Asia. These regions have the highest excess mortality of girls in the world, with a sex ratio of infant mortality in the 2000s of 90 in East and South East Asia (101 for child mortality) and 101 in South Asia (64 for child mortality) (United Nations, 2011). The figures of Alkema et al. (2014b) for 2012 confirm the high excess mortality of girls aged between one and five in South Asia and the lack of progress since 1990 (from 0.75 to 0.79). In 2012, excess female child mortality was still high in Pakistan and Nepal; only in Bangladesh has it disappeared. Of course, China and India weigh heavily in those regional averages.

China, like India, has been the focus of considerable research on the status of women, and has doubtless long been one of the most unequal countries in terms of under-five mortality, especially in rural areas (Attané and Barbieri, 2009). Despite achieving relatively low levels of under-five mortality (24 deaths before age five per 1,000 live births in 2005), China still exhibited excess female mortality in the first two years of life in the 2000s (United Nations, 2011). More surprisingly, between the 1970s and the 2000s, the situation appears to have worsened for infant mortality (below 12 months), but improved for child

(32) In this region, and others, excess female mortality persists after age five.

mortality (between one and five years). According to the life tables published in the latest revision of the UN Population Division (2015), excess mortality of girls had disappeared by 2015; indeed, excess male mortality now reportedly stands at around 11% for infants below 12 months and for children aged 1-5,<sup>(33)</sup> although it is still below the level to be expected in the absence of discrimination (Hill and Upchurch, 1995). Alkema et al. (2014b) arrive at a similar result for 2012 (15%). Those results would need to be confirmed with very recent data. Moreover, they give no indication of the likely variability within the country, between different provinces and between urban and rural areas.

Bannister (2004), Li et al. (2004) and Das Gupta (2009), and more recently Guilмото (2015), among others, suggest explanations for the historic discrimination against girls and preference for boys in China, including the rigidity of the patrilineal family system, the importance of a son for ensuring the survival of the lineage and for ancestor worship, and the fact that a daughter is married off early and belongs to her in-laws. The impact of these factors has been further amplified by the one-child policy and the recent context of the privatization of health services, the high cost of education, and increasing socio-economic inequalities. To tackle the problem, the Chinese government implemented a national campaign called Care for Girls in 2006 to combat the causes of excess female mortality and sex-selective abortion. We may now be witnessing the initial effects of that campaign.

India, which for many years had much higher under-five mortality than China (UNICEF, 2015),<sup>(34)</sup> has a slightly different, well documented, history. Unlike China, where excess female mortality occurs (or occurred) early (during the first days or weeks of life), in India it occurs later (although still beginning in the post-neonatal period) and persists for longer (United Nations, 2011; Sawyer, 2012). Alkema et al. (2014b) found almost no change between 1990 and 2012 and estimate that excess mortality of girls between one and five years stands at almost 30%. Our analysis of the official life tables for the years 1995-1999 and 2006-2010, assuming they are reliable, confirms the virtual lack of change over the period: there is near equality of mortality between boys and girls under 12 months, and around 32% excess mortality of girls between one and five years (with, unexpectedly, few differences between urban and rural areas nationally). But again, these national averages mask diverse situations in different states: excess female mortality was observed in the large Indian states, particularly in the north and centre-north, in 2008 (Arokiasamy, 2007).

As in China, excess female mortality in India has long been attributed to the rigidity of the patrilineal family systems in much of the country, especially the north, under which women and girls are subordinate to boys, represent a

(33) We could not access the life tables constructed by the Central Bureau of Statistics of China (based on 2010 census data) to publish life expectancies for each sex.

(34) The differences between India and China even increased between 1990 and 2015, with the ratio between the two countries' under-five mortality sex ratios increasing from 2.3 to 4.2.

financial disincentive (a daughter will leave the family early), and have little independence or decision-making power (Das Gupta, 2009; Dyson and Moore, 1983). This is reflected in inequalities in terms of breastfeeding, food and access to healthcare, and in neglect of girls of high birth orders. However, based on the National Family Health Survey, Kuntla et al. (2014) identify progress between 1992 and 2006: they confirm that the excess mortality of girls decreased over that period, although it still remains high, especially in northern and central India.

## 5. Socioeconomic and cultural inequalities: progress and diverse trends

Social inequalities in terms of income, education, access to healthcare, place of residence and environment, lead to differentiated behaviour by mothers and families, and to disparities in child mortality across social groups (Caldwell, 1979; Gwatkin, 2000). Different explanatory frameworks for child survival were proposed for developing countries in the 1980s and 1990s, after that of Mosley and Chen (1984), one of the oldest and most widely used (for a summary, see Masuy-Stroobant, 2005). Most identify three levels of determinants or actions: first, social and health policies; second, individual characteristics (biological, behavioural and social characteristics of mothers and children), households (resources, crowding, etc.) and communities (environment, service provision, etc.); and third, the child's potential for illness (exposure to infectious diseases, vulnerability and resistance). The impact of these different determinants varies over time and space. We examine here the state of knowledge on inequalities by mother's educational level, household income and place of residence, the three most widely researched discriminating factors.<sup>(35)</sup>

To illustrate the change in inequalities, we use under-five mortality in six of the ten selected countries (Bolivia, Burkina Faso, Egypt, India, Indonesia and Nigeria), where two DHS surveys were conducted approximately 15 years apart.

### *The long-established and universal role of mothers' education*

Both public health policymakers and demographers have long recognized the positive role of mothers' education on child health and mortality. In a macro-geographical study of 175 countries, Gakidou et al. (2010) attribute 51% of the decline in under-five mortality between 1970 and 2010 to improvements in female education between the ages of 15 and 50.<sup>(36)</sup>

(35) Here we consider only the inequalities between sub-populations within countries. We will not enter into the international debate, more connected to economics, on the relative contributions of education, economic development, political governance or budget priorities to reducing under-five mortality. See, for example, Houweling et al. (2005), Schell et al. (2007) and Hajizadeh et al. (2014).

(36) This estimate is similar to the one proposed in the late 1980s by Cleland and van Ginneken (1988).



All surveys and censuses show a clear link between inequalities in child survival and mothers' educational levels: the more literate the mother, the lower her children's mortality risk. The risk quadruples between mothers with post-secondary education and illiterate mothers. Having attended school, even only primary school, leads to better child survival almost everywhere. Inequalities by mother's educational level are often highest for children between one and five years old, at least in contexts where overall mortality is high. The role of education probably varies by country<sup>(37)</sup> and period, but it is important, whatever the mortality level. Figure 8 illustrates the situation in the six selected countries.

Though weaker, the impact of education persists after controlling for other variables in multivariate analyses. Fuchs et al. (2010) have already shown that the mother's education is more important than household income for reducing under-five mortality in developing countries. In a recent study of 50 low- and middle-income countries, based on DHS data (2003-2013), Gaigbe-Togbe (2015) re-examined the determinants of child survival by focusing on educational level, income, and place of residence. The study found that after controlling for income, in most countries, mothers' education still had a significant independent impact on the mortality risk, that this impact varied across world regions,<sup>(38)</sup> and that it increased with income.

But how have inequalities by educational level changed since the 1990s? Where has the fastest progress occurred? Let us examine the situation in the six countries shown in Figure 8A and Table 7. Overall, we observe a diversity of patterns. Excluding Nigeria (slow progress for all groups), the fastest improvements occurred among the least educated mothers (no education or only primary schooling), whose children had high mortality in the 1990s (100 or higher per 1,000 live births). This was the case in Egypt, for example. With much lower base levels, the pace of decrease among the children of mothers with higher education was two or three times slower.<sup>(39)</sup> Inequalities have become smaller in these countries, but there is still a strong education gradient.

Mothers' education<sup>(40)</sup> is closely linked to the status of women, their decision-making power in the household, their contact with the outside world, their ability to talk to and negotiate with the health services, and their knowledge (Caldwell, 1979, 1986; Cleland and van Ginneken, 1988). But it is also linked to the standard of living and financial resources of their household.

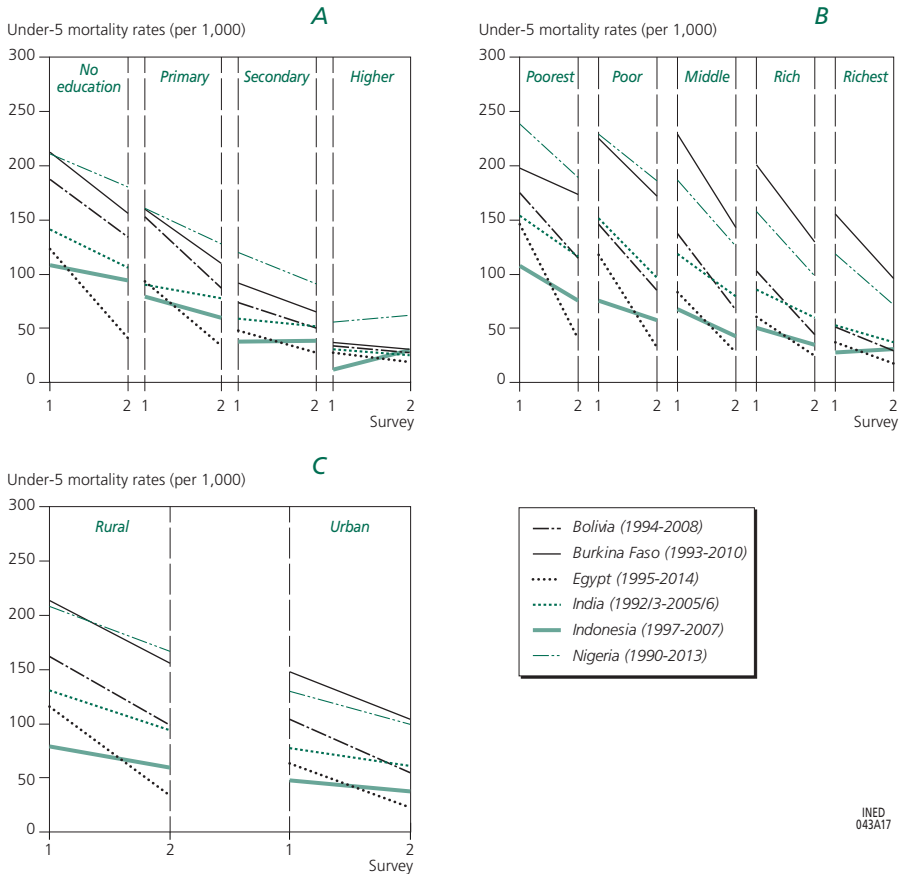
(37) Sometimes even between countries at the same stage in the epidemiological transition.

(38) The differential between primary schooling and illiteracy in terms of impact on child health is smaller in Africa than in Asia and Latin America.

(39) Their mortality appears to have increased to a surprising extent in Indonesia, and to a lesser degree in Nigeria.

(40) Regrettably, few studies explore the role of the father's education combined with that of the mother. See the work of Macassa et al. (2003) on Mozambique.

Figure 8. Changes in under-five mortality rates between two DHS waves in six countries, (A) by mothers' educational level, (B) household wealth and (C) place of residence



Source: DHS surveys (<http://dhsprogram.com>).

INED  
043A17

### Household wealth: now a key factor

Without forgetting education, the focus of research in the 1990s and 2000s shifted to household economic status, standard of living and poverty as potential determinants of child health. New questions were included in the DHS/MICS surveys to measure the economic well-being of households as a proxy for income and new indicators were developed to compensate for the lack of data on household income or expenditure.<sup>(41)</sup> It is now possible to measure inequality levels and trends by what we shall simply call household wealth.

(41) Most socio-demographic surveys do not include questions on household income or expenditure. The DHS/MICS data can be used to estimate a “wealth index”, based on various physical assets owned by the household and on features of the dwelling (electricity, access to drinking water, construction materials) using a factor analysis. The total score for a household is attributed to each resident member and the sample is divided into population quintiles from 1 (the lowest) to 5 (the highest).

**Table 7. Annual rate of reduction (%) in under-five mortality between two DHS surveys in six countries, by mothers' educational level, household wealth and place of residence**

Country	Bolivia	Burkina Faso	Egypt	India	Indonesia	Nigeria
Survey 1	1994	1993	1995	1992/3	1997	1990
Survey 2	2008	2010	2014	2005/6	2007	2013
<b>Educational level</b>						
No education	2.4	1.8	5.8	2.2	1.4	0.7
Primary	4.0	2.2	5.3	1.1	2.8	1.0
Secondary	2.8	2.0	2.8	1.0	-0.3	1.2
Higher	1.4	1.0	2.0	1.7	-9.2	-0.4
<b>Household wealth quintiles</b>						
Poorest	3.0	0.8	6.6	2.1	3.5	1.0
Poor	3.8	1.6	6.6	3.4	2.7	0.9
Middle	5.1	2.8	5.7	3.0	4.5	1.7
Rich	5.8	2.5	4.6	2.7	3.7	2.0
Richest	3.8	2.8	3.8	2.5	-1.0	2.2
<b>Place of residence</b>						
Rural	3.5	1.9	6.5	2.6	2.8	1.0
Urban	4.6	2.1	5.4	1.9	2.3	1.1

*Source:* DHS surveys (<http://dhsprogram.com>).

Unsurprisingly, the richer a household, the lower the child mortality: the recent literature is unanimous on that point. But this inequality results not only from the often huge gulf between rich and poor; it follows a more or less linear social gradient of decreasing mortality from the poorest to the richest quintiles (Houweling et al., 2005; Houweling and Kunst, 2010). Figure 8B illustrates this pattern for six countries. Like the impact of education, the under-five mortality differentials between wealth quintiles vary over time and between countries. In the poorest countries with the highest mortality, like Burkina Faso, the differentials between the poorest, poor and middle-income quintiles are relatively small; lower mortality is only clearly visible among the richest elite.

Gaigbe-Togbe's analysis (2015) of the individual risk of death in 50 countries confirms, for the recent period, the crucial role of household wealth in child survival, after controlling for educational level. In these 50 countries, the study found few differences between the poorest and the poor quintiles; a clear gap only emerged between the middle-income, rich and, especially, richest quintiles. The highest correlations between household wealth and under-5 child mortality were found in Latin America and Asia, and the lowest in Africa. Moreover, the author shows that household wealth had a bigger impact on child mortality (1-4) than on infant mortality. Wealth generally rises with education, but when education is controlled for in the models, the impact of household wealth on child mortality decreases, and in some cases becomes non-significant.

How have these economic inequalities changed since 1990 and 2000? Bendavid (2014) recently explored the question through a macro-analysis of under-five mortality, based on the combined DHS data from 54 countries, including 29 countries with two surveys between 2002 and 2012. Working with wealth tertiles (least poor, middle-income, and poorest), but without controlling for other variables such as education or place of residence, the analysis confirmed the role of wealth (or poverty) at a specific time. The main finding was that the poorest group saw the fastest annual declines in mortality in the 2010s: annual rates ranged from 2.1% to 4.4% between the extreme tertiles (average of 29 countries). The author also observed a pattern of convergence, while noting that it is far from universal. The findings of the recent WHO report (WHO, 2015b) on child health in 86 low- and middle-income countries support this trend: the economic inequalities in under-five mortality have narrowed in a majority of countries. But this average may mask divergent patterns between countries.

In the six selected countries (Figure 8), over the 15 years covered, the average mortality reductions are substantial across all social groups (quintiles), but occurred at different speeds and in different ways in each country. In the two most disadvantaged countries in the sample (Burkina Faso and Nigeria), but also in Bolivia, mortality fell fastest in the richest groups, two to three times faster than in the poor and poorest groups. Conversely, the poor and poorest quintiles saw the most progress in Egypt between 1995 and 2014, whereas India and Indonesia showed few significant differences in mortality trends by wealth quintile. In other words, based on these few examples, no overall trend can be identified: inequalities in under-five mortality by level of household wealth increased in some countries, especially those with the highest mortality (Bolivia, Burkina Faso, Nigeria), decreased in others (Egypt), and remained stable in yet others (India, Indonesia).

### *Place of residence: persistent urban-rural inequalities*

The many studies of child survival differentials by place of residence show that mortality in low- and middle-income countries has consistently been significantly higher in rural than in urban areas (Cleland et al., 1992; Cleland and Harris, 1998; Gould, 1998; Günther and Harttgen, 2012; Lalou and Legrand, 1997).<sup>(42)</sup> The urban-rural gap varies, of course, by period and country, and depends on the type and pace of urbanization, the respective socioeconomic characteristics of the two types of area (education, wealth, etc.), and on health policies. In a large literature review for the period 1975-1990, Sastry (1997) showed that child mortality differentials by place of residence persisted after controlling for education and various household characteristics, though they were often smaller. According to our calculations, based on the most recent

(42) In 2015, 51% of the population in middle-income countries was living in urban areas, compared with only 31% in low-income countries.

DHS surveys (2008-2014),<sup>(43)</sup> excess rural under-five mortality is relatively independent of the national level of mortality: between 40% and 50% in countries as different as Nigeria, Bolivia, Afghanistan and Egypt, 34% in Indonesia and Burkina Faso, and only 19% in the Democratic Republic of Congo, where mortality is high in cities and countryside alike. In the neonatal period (the first 28 days of life), the rural/urban divide is of similar magnitude, but slightly lower in countries with lower child mortality and better healthcare provision in terms of infrastructure and personnel.

Urban-rural inequalities have narrowed overall in the past 20 years (Garenne, 2010; WHO, 2015b), but again the differentials vary across countries, depending on the social and health policies implemented (particularly investment in rural areas) and on the socioeconomic situations of the cities.<sup>(44)</sup> For example, under-five mortality has fallen much faster in rural than in urban areas in Egypt, India and Indonesia (Figure 8C), at the same speed in Burkina Faso and Nigeria, and much more slowly in rural areas in Bolivia. It is therefore hard to generalize.

For some time, a debate has been running about current and future health in cities, in particular large cities and metropolises (Brockerhoff and Brennan, 1998). Some authors (e.g. Gould, 1998), now in the minority, have maintained that rapid urbanization would spur the mortality transition; others hold that urbanization, which is often uncontrolled and accompanied by an increase in informal settlements and poverty, insufficient healthcare and environmental services (water management, waste management, pollution control, etc.), is generating huge intra-urban inequalities and a deterioration in urban health which could even lead to an increase in urban mortality rates. The concept of “urban penalty” refers to excess urban mortality such as that observed in nineteenth-century Europe, when industrial cities were characterized by poverty, a lack of personal and collective hygiene, and non-existent or deficient social and health services (on the concepts and debates, see Bocquier et al., 2011; Maïga and Bocquier, 2016; Ramiro-Fariñas and Oris, 2016).

With increasing socio-spatial segregation in large cities, in particular the extension of peripheral neighbourhoods and slums, intra-urban inequalities have become a key theme in local health action programmes (Fink et al., 2014). According to Montgomery (2009), cities have an overall advantage, but the children from the poorest households, whose numbers are increasing, are no better off than in rural areas. The study by Kyu et al. (2013), conducted on 45 countries, reveals the strong negative impact of residence in a slum on child health (particularly stunting),<sup>(45)</sup> after controlling for other household

(43) The estimates based on DHS data can be viewed at: <http://www.statcompiler.com/fr/>.

(44) Some countries show little difference, particularly those affected by HIV/AIDS: e.g. Zambia (DHS 2007), Malawi (DHS 2010), Zimbabwe (DHS 2010).

(45) In 2010, more than 800 million people in developing countries (33% of the urban population) were living in an informal settlement or a slum.

characteristics. This is the case in Nairobi, where half of the population lives in slums, and in many other large cities in the South (e.g. Soura (2009) on Ouagadougou). Günther and Harttgen (2012), who studied ten African countries, found an average 65% excess mortality among children living in slums compared with those living in formal housing, and concluded that mortality inequalities within cities are greater than between rural areas and slums. We need to bear in mind, however, that rural areas (less well documented in terms of inequalities) are never a homogeneous whole, and also encompass a diversity of situations.

### *Proximate determinants of mortality: immunization coverage and malnutrition*

While child mortality has fallen significantly everywhere and spatial and social inequalities are regressing overall, what about the trends in proximate determinants such as child immunization and malnutrition, two factors underlying the mortality transition at young ages?<sup>(46)</sup> Again, most studies are based on DHS/MICS data. In the abundant literature on these determinants, we focused on a WHO report (2015b) and on Rutstein et al. (2016), which both looked at changes in socioeconomic inequalities in low- and middle-income countries in the 2000s.

Large differences in immunization are observed between countries. For example, over a 13-year period, full basic immunization<sup>(47)</sup> coverage increased from 44% to 81% in Burkina Faso and remained at around 91% in Egypt, while coverage rose only from 13% to 25% over a ten-year period in Nigeria. Regarding within-country differences, in 26 low- and middle-income countries (Rutstein et al., 2016), towns fare, on average, slightly better than cities, and much better than rural areas (coverage rates of 58%, 53% and 45%, respectively). Unlike other variables, immunization coverage in cities varies little with household wealth; today it is only among the poorest rural populations that coverage is particularly low (33%). Progress is visible everywhere. According to Rutstein et al. (2016), it is more evident in cities and in the richest population groups in all three places of residence (cities, towns and rural areas), whereas according to the WHO, on a larger, more heterogeneous sample of 86 countries, the gaps between the richest and poorest have narrowed in a majority of cases (WHO, 2015a). Almost everywhere, there is little difference in immunization coverage between boys and girls (WHO, 2015a).

The nutritional status of children, measured by stunting, bodyweight and prevalence of anaemia, is still, as to be expected, strongly associated with place of residence, household poverty and mothers' educational level. Children's nutritional status is better in middle-income countries than in poor countries (WHO, 2015a) and is positively correlated everywhere with mothers' educational

(46) We do not address other factors here: mothers' fertility, birth spacing, prematurity or birth weight.

(47) Defined in the DHS and measured on children aged 12-23 months as BCG, DPT, polio, and the first dose of the measles vaccine.

level. There have been significant improvements in all population groups, but stunting in children remains linked to the place of residence (it is two to three times more frequent in rural areas than in cities) and household poverty (children in the poorest households, in both urban and rural areas, are between twice and almost three times more likely to be stunted than children from non-poor households; Rutstein et al., 2016). The same inequalities are observed for underweight children, but there was no major change in prevalence in the 2000s. Regarding anaemia, the average prevalence is very high in cities (42% of children) and in rural areas (57%), and increases significantly from wealthy households (30%) to poor households (39%) and very poor households (60%). Clear advances have been made, however, and on the whole they tend to benefit the most disadvantaged populations.

All these elements are contributing to the rapid decline in child mortality and illustrate the progress achieved; but they also reveal the persistence of large social, economic and geographical inequalities between and within countries.

#### IV. Adult mortality: a moderate overall decrease

Adult mortality in low and middle-income countries has long been neglected by demographers, partly because data are scarce, but also because the few available sources have not been frequently exploited. Interest in the issue has recently increased as child mortality has fallen, particularly in the context of efforts to monitor maternal mortality and mortality linked to HIV/AIDS. Various attempts have been made to estimate mortality among persons aged 15-60 years across the world, (see Rajaratnam and colleagues, 2010), and some estimates are regularly updated as part of the Global Burden of Disease survey (GBD collaborators, 2016). For maternal mortality, we will refer to the most recent estimates from United Nations agencies (Alkema et al., 2016).

This study is limited to events before the age of 60 years, however, as mortality at more advanced ages is very difficult to measure (Bendavid et al., 2011). Deaths in old age are more likely to be under-reported, and age-reporting errors are also common (Randall and Coast, 2016). Consequently, levels of mortality above age 60 in many countries are often estimated using model age patterns of mortality and are thus not based on real data. This means that a growing proportion of deaths are currently unobserved. In 2015, 55% of deaths in low- and middle-income countries occurred beyond age 60. In 2060 this proportion could reach 83% (United Nations, 2015), the current level in high-income countries.

Even below age 60, analyses rarely focus on inequalities in mortality, again due to a lack of data. With a few exceptions, such as the World Bank's Living Standards Measurement Study (LSMS), which includes questions on the occupation and educational level of deceased family members, little information is available on deceased persons. At best, it is limited to the circumstances of

death and the symptoms that preceded it, which can be used for cause-of-death analysis. Other aspects of the deceased – ethnicity, religion, standard of living, region of residence, and level of education – generally remain unknown. Given this lack of information on deceased persons, some studies have explored the possibility of using available information on surviving survey respondents (i.e. the relatives of the deceased) to obtain some idea of inequalities in mortality, however approximate (De Walque and Filmer, 2011; Graham et al., 2004; Timæus, 1984). But their conclusions must always be treated with caution, as the respondents’ characteristics do not necessarily reflect those of the deceased.

## 1. Highly variable rates of mortality decline across regions

### General trends

At the global level, between 1990 and 2015, adult mortality decreased almost three times more slowly than child mortality (Table 8). While under-5 mortality fell by an average of 3% per year over the period, the annual rate of decrease for adults aged 15-60 was only 1.1% for men and 1.2% for women.

**Table 8. Male and female probability of dying between ages 15 and 60 by region and country’s income category, in 1990 and 2015**

	Adult mortality $_{45}q_{15}$ (per 1,000)					
	Men			Women		
	1990	2015	Relative decrease (%)	1990	2015	Relative decrease (%)
<b>By country category</b>						
High-income	188	133	-29	87	66	-25
Upper-middle-income	192	134	-30	129	88	-32
Lower-middle-income	276	224	-19	220	154	-30
Low-income	392	280	-29	334	233	-30
<b>By region (low- and middle-income countries only)</b>						
North Africa (6)	233	172	-26	168	114	-32
Sub-Saharan Africa (42)	397	329	-17	335	286	-15
East Asia (3)	155	99	-36	116	72	-38
South and central Asia (12)	273	203	-26	226	136	-40
South-East Asia (9)	239	212	-11	171	128	-25
Western Africa (10)	230	177	-23	140	101	-28
Latin America (17)	257	178	-31	149	95	-36
Europe (9)	260	240	-8	113	96	-15
World	230	176	-23	159	118	-26
<i>Note:</i> The regional averages were obtained by weighting the probabilities of dying by the size of the population aged 15-59; they may therefore differ from WPP 2015 estimates.						
<i>Source:</i> Authors’ calculations based on WPP data (2015).						



Expressed as relative decreases, these changes represent a drop of between 19% in lower-middle-income countries and 30% in upper-middle-income countries for men, and around 30% for women regardless of income category. The slower decline among men in lower-middle-income countries is due to low rates of progress in Indonesia (0.2% decrease per year), Pakistan (0.8%), Nigeria (0.4%), and the Philippines (0.2%).

In high-income countries, between 1990 and 2015, the risk of death between ages 15 and 60 was about twice as high for men as for women (Table 8). The sex ratio of adult mortality (ratio between men's and women's risks of dying) is lower in poor countries: in low-income countries in 2015 it stood at only 1.2. Overall, men's adult mortality disadvantage has slightly increased over the years, particularly in lower-middle-income countries. We will return below to the question of the determinants of these sex inequalities in adult mortality.

Table 8 also highlights large disparities in progress between regions. In 1990, sub-Saharan Africa stood out from other geographical regions, with a risk of death between ages 15 and 60 of nearly 400 per 1,000 for men and 330 per 1,000 for women. In contrast, adult male mortality in East Asia was the lowest among all low- and middle-income countries, while adult female mortality was slightly higher than that of European middle-income countries. This regional average was, in fact, largely determined by China, where by 1990 the risk of dying between ages 15 and 60 had already fallen to 155 per 1,000 for men and 116 per 1,000 for women. In other regions, in 2015, adult mortality in low- and middle-income countries ranged between 230 and 280 per 1,000 for men, and between 110 and 230 per 1,000 for women.

Over the last 25 years, worldwide inequalities between countries in different income categories have persisted. Adult mortality among men living in low-income countries is double that of men in high-income countries; the ratio for women is 3.5. The disparities between broad geographical regions have widened, with faster decreases in East Asia, South and Central Asia, North Africa, and Latin America, contrasting with low rates of progress in sub-Saharan Africa and Europe. In South-East Asia (Indonesia, Philippines), progress has been slow among men, but twice as fast among women. Consequently, women's advantage in adult survival has increased slightly in almost all regions.

These regional averages mask relatively diverse patterns of change between 1990 and 2015, which can be seen in Figure 9. Adult mortality decreased in most countries over this period (below the diagonal), with the exception of Syria (for men) due to the recent conflicts, and a number of African countries that have been severely affected by the HIV/AIDS epidemic. A few countries show particularly rapid progress: in Iran, Lebanon, Nepal, Morocco, Cambodia, and Timor-Leste, adult mortality has fallen by more than half in the last 25 years.

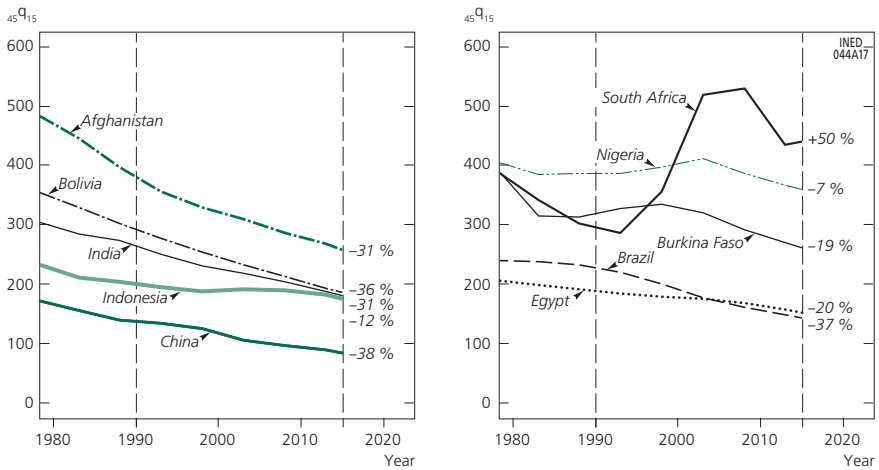
Figure 10 presents the probability of dying between the ages of 15 and 60 years ( ${}_{45}q_{15}$ ) from 1990 to 2015 by five-year periods, for the 10 selected countries chosen for analysis here. There have generally been steady decreases

Figure 9. Change between 1990 and 2015 in the risk of dying (per 1,000) between ages 15 and 60, in 108 countries classified by 2015 income level, by sex



Source: United Nations (2015).

Figure 10. Risk of death between ages 15 and 60 (per 1,000, both sexes combined) in 10 countries by five-year periods



Source: United Nations (2015).

over the period, with the exception of the three sub-Saharan African countries affected by HIV/AIDS, and of Indonesia, where the last 15 years have not seen clear progress.<sup>(48)</sup>

(48) This observation was confirmed by the DHS surveys for these countries. We did not uncover any explanatory factors for these rapid advances.

### *Impact of the HIV/AIDS epidemic on adult mortality trends*

The countries where adult mortality trends have been most disrupted over the past 25 years are those most severely affected by the AIDS epidemic. As most HIV infections are sexually transmitted, deaths due to AIDS are mainly concentrated among adults. According to the latest estimates from the Joint United Nations Programme on HIV/AIDS, out of the 1.1 million persons who died of AIDS in 2015, 91% were 15 years old or above.<sup>(49)</sup>

Detectable increases in adult mortality due to the epidemic were observed in the late 1980s in several East African countries, such as Uganda, Zambia, and Malawi (Blacker, 2004; Timæus and Jasseh, 2004). The epidemic then developed and expanded into other countries, particularly in southern Africa, where HIV prevalence reached its highest levels. In Zimbabwe, for example, according to UNAIDS data, up to 26% of the adult population aged 15-49 years was HIV-positive in 1997. According to DHS data, the probability of dying between ages 15 and 60 years tripled in that country, rising from 21% among men in 1985 to 65% in 2000 (Masquelier et al., 2014a). HIV prevalence subsequently decreased, falling to 15% in 2015,<sup>(50)</sup> and adult mortality likewise (from around 2005), although it has not returned to pre-epidemic levels. Zimbabwe is one of the countries where adult mortality has been most affected by the epidemic, due to extremely high HIV prevalence (Feeney, 2001). Only in seven other countries, all located in or close to southern Africa,<sup>(51)</sup> did prevalence exceed 15% among adults aged 15-49 years. In South Africa, HIV prevalence increased steadily to 21% in 2004, before declining very slowly to 19% in 2015. Today it is the country with the largest population of infected persons, estimated at 7 million. Up to the early 1990s, adult mortality in the country decreased steadily, but then surged to more than 500 deaths before age 60 per 1,000 individuals aged 15 (Figure 10). The continued spread of the epidemic in southern Africa until recent years explains why some countries in the region have still not returned to their 1990 levels of adult mortality (Figure 9). In East Africa, prevalence in a number of countries also rose above 5% (Kenya, Mozambique, Rwanda, Tanzania, Uganda), but these countries controlled the epidemic more rapidly. Uganda, for example, reached its peak prevalence in 1991 (13%) but the probability of dying between ages 15 and 60 in the country has decreased by more than a third since 1990 (United Nations, 2015). This is also the case in Ethiopia, Rwanda, Tanzania and Zambia. Overall, prevalence has already peaked in almost all countries, but it remains high in southern Africa. With the increasing use of antiretroviral treatments, a growing proportion of the HIV-positive population survives for longer, which partly explains this persistence.

Although the proportion of AIDS deaths has been smaller in West and Central Africa, the disease has also disrupted mortality trends in a number of

(49) Source: AIDSInfo (UNAIDS), <http://aidsinfo.unaids.org/>, consulted on 21/11/2016.

(50) Ibid.

(51) Zambia, Malawi, Namibia, South Africa, Lesotho, Botswana, Swaziland.

countries in these regions, such as Burkina Faso, Cameroon, Côte d'Ivoire and Nigeria. Figure 10 presents the cases of Nigeria and Burkina Faso. In Nigeria, around 3.4 million individuals are currently infected with the virus; this is the second-largest HIV-positive population in the world, after South Africa.<sup>(52)</sup> The prevalence of the virus in the country reached 4% of the adult population around 2001, its highest level, and has subsequently remained above 3% (Mahy et al., 2014). According to United Nations estimates, adult mortality in the country increased slowly up to the period 2000-2005, before dropping off slightly. In Burkina Faso, HIV prevalence among adults peaked at 3.8% in 1993, and since 2012 it has fallen to below 1%. Between 1998 and 2001, AIDS caused more than 14,000 deaths in the country each year, i.e. around one in 12, whereas today it causes only one in 50.<sup>(53)</sup> As in other countries, this improvement can be attributed to a combination of favourable factors, principally a decrease in high-risk sexual behaviours following prevention campaigns, and the scale-up of antiretroviral treatments beginning in 2005.

In 2000, only around 200,000 persons infected by the virus had access to these treatments in low- and middle-income countries, most of them outside sub-Saharan Africa (Brazil, Thailand). But the resources devoted to persons living with HIV in those countries were subsequently increased more than four-fold – from 4.8 billion dollars in 2000 to 20.2 billion in 2014 – notably thanks to international initiatives such as the PEPFAR programme<sup>(54)</sup> (Bendavid et al., 2012) and the Global Fund to Fight AIDS, Tuberculosis and Malaria (UNAIDS, 2015). In 2014, antiretroviral coverage in low- and middle-income countries was 40%, with a total of 13.6 million persons receiving treatment. The latest WHO treatment recommendations, from 2015, stipulate that all HIV-infected individuals should begin treatment as quickly as possible following diagnosis. It is thus more crucial than ever not only to ensure universal treatment, but also to expand HIV testing. According to UNAIDS, in 2014 only 54% of infected persons knew that they were HIV-positive (UNAIDS, 2015), and knowledge varied by age, sex, and level of poverty. A recent survey in Mozambique showed that 61% of HIV-positive individuals were unaware of their status, and that this proportion was highest among men and members of poorer households (Dokubo et al., 2014). These persons cannot be reached or treated by the healthcare services, and expose their partners to the risk of infection.

## 2. Growing sex inequalities in adult mortality

Traditionally, adult mortality is lower among women, due to biological (notably hormonal) determinants, but above all due to social and behavioural

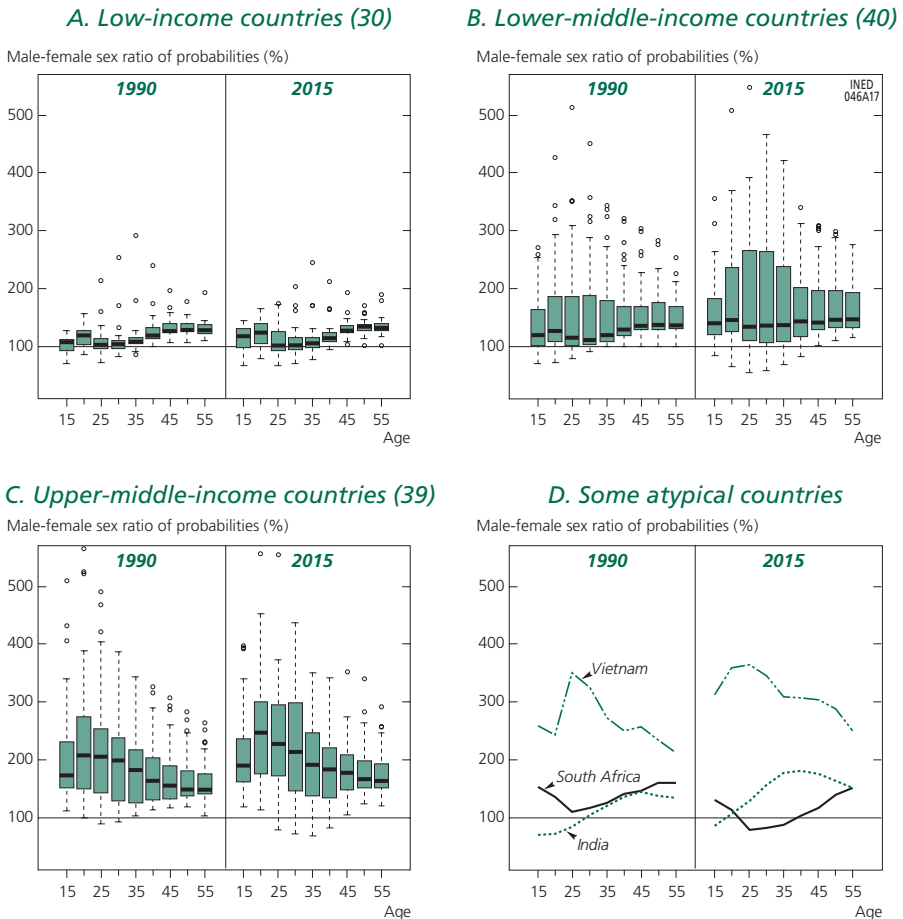
(52) National Agency for the Control of AIDS (NACA), Global AIDS Response - Country Progress Report Nigeria GARPR 2015, [http://www.unaids.org/sites/default/files/country/documents/NGA\\_narrative\\_report\\_2015.pdf](http://www.unaids.org/sites/default/files/country/documents/NGA_narrative_report_2015.pdf)

(53) Sc: AIDSInfo (UNAIDS) <http://aidsinfo.unaids.org/>, consulted on 21/11/2016.

(54) The United States President's Emergency Plan for AIDS Relief, the largest bilateral support programme devoted to a single disease, launched by President G. W. Bush in 2003.

differences (less alcohol and tobacco consumption, fewer accidents, etc.) (Rogers et al., 2010). Women’s advantage tends to increase as mortality declines, as the proportion of deaths from infectious diseases and conditions linked to pregnancy decreases, and that of cardiovascular diseases and cancers increases, to the disadvantage of men (Nathanson, 1984). In low- and middle-income countries, sex disparities have, in fact, widened slightly over the last 25 years, as Figure 11 shows.

**Figure 11. Male-female ratios of probabilities of dying at ages 15-60, by age group, country category and period and for some atypical countries, in 1990 and 2015**



**Note for figures A, B, C:** these boxplots present the distribution of values of the sex ratios of probabilities of dying by age group, from 15-19 to 55-59 years. For each age group, the vertical rectangle includes half of all countries. In each case, the sex ratio in a quarter of countries is above the upper line of the rectangle, and for another quarter it is below the lower line. The dark line within the rectangle shows the median. By convention, the dotted lines indicate the position beyond which the observations are considered outliers (they are represented by a circle and are at a distance of at least one and half times the interquartile range).

Source: United Nations (2015).

This figure presents the sex ratio (M/F) of age-specific probabilities of dying for adults, according to UN estimates (2015). It can be seen that women's advantage is markedly smaller in low-income countries than in countries in the other two categories. For all low-income countries combined, the sex ratio of mortality in 1990 ranged from 105 (excess male mortality of 5%) among 30-34 year-olds to 130 among 55-59 year-olds. These ratios were slightly higher in 2015, but they remained below 140 at all ages. In lower middle income countries, the variation in excess male mortality is larger, principally between the ages of 20 and 35 years, which reflects the more diverse levels of adult mortality in this category. The few countries with extremely high excess male mortality include Syria, due to armed conflict, but also Georgia, Armenia, and two countries where adult mortality has already reached fairly low levels, Sri Lanka and Vietnam (Figure 11B). The configuration in India is atypical (Figure 11D); women's mortality is higher than men's in early adulthood (before age 30 in 1990, before age 20 in 2015), and becomes lower only at later ages. Finally, in upper middle income countries, excess male mortality is higher, with a mean sex ratio of more than 180 among adults aged 15-30, progressively decreasing with age to about 150 at ages 55-59. These ratios have slightly increased over the last 25 years.

The pattern also differs for countries strongly affected by HIV/AIDS, such as South Africa (Figure 11D), where the ratios are much lower than those observed elsewhere. Sex differences in adult mortality tend to decrease where AIDS-related mortality is high (Masquelier et al., 2017). This phenomenon has notably been observed in Agincourt, in South Africa, where adult mortality increased more quickly among adult women (Kahn et al., 2007). This is explained by differences in the risk of contracting the virus by sex and by stage of the epidemic. Initially, men are more likely to be infected, due to high-risk sexual behaviours such as commercial sex. Later, infections among women outnumber those among men, due to age differences between sexual partners (exposing younger women to older partners who are thus more likely to be infected) (Gregson et al., 2002) and to women's greater biological vulnerability. On the basis of 20 national surveys that collected data on HIV prevalence in sub-Saharan Africa after 2001, García-Calleja and colleagues (2006) estimated a female-to-male prevalence ratio of around 1.5.<sup>(55)</sup> Few data are available on recent trends in the sex ratio in HIV infections, so we can do no more than speculate about how the situation will evolve in response to changes in behaviour and the broader diffusion of treatments. In recent years, the decrease in AIDS-related mortality seems to have benefited women more than men, possibly because of women's more frequent take-up of treatments and healthcare services for infected persons (Muula et al., 2007; Reniers et al., 2014).

(55) This is confirmed by the results of all DHS surveys as compiled using Statcompiler <http://www.statcompiler.com/fr/>, consulted November 2016.

### 3. The spatial inequalities of adult mortality differ from those of child mortality

The abundant literature on spatial inequalities in under-5 mortality in the Global South contrasts with the paucity of research findings on adult inequalities (Belon et al., 2012; Günther and Hartten, 2012; Khosravi et al., 2007; Lankoande and Sié, 2017). Even without descending to very fine infra-national scales, the simple question of differences in mortality between urban and rural areas is rarely documented. A common hypothesis is that adult mortality, like that of children, is lower in urban areas thanks to better healthcare infrastructure and living conditions (nutrition, employment, education, etc.; Dye, 2008). But it is risky to draw conclusions about adults based exclusively on analysis of inequalities in children. Mortality does not always change at the same rate in the two age categories, notably in response to the HIV/AIDS epidemic. At country level, child mortality is not always a good predictor of adult mortality, and it may be supposed that the same is true at sub-national levels. Moreover, child mortality continues to be dominated by infectious diseases, whereas a growing proportion of adult deaths are caused by chronic diseases. As the risk factors for these different causes of death are not the same, the geography of child mortality could differ from that of adults.

A good illustration of this disconnection between child and adult mortality can be found in India, where data from various surveys and from the Sample Registration System (SRS) have been used to analyse inequalities in adult mortality at the district level (an administrative unit with an average of 2 million inhabitants) (Ram et al., 2015). This analysis reveals a difference of around 10 years in life expectancy between high-mortality districts and others – almost as large as the difference between high-income countries and India as a whole. A fairly clear geographical pattern emerges, particularly for women, opposing districts in the east of India (with high mortality) and districts in the west (with low mortality). This distinction does not correspond to the geography of child mortality, which is marked by a north-south divide.

Günther and Harttgen's (2012) analysis of sub-Saharan Africa offers another example, this time bearing on urban-rural differences. These authors analysed information collected in DHS surveys from adult women concerning the survival of their siblings and of their children in order to estimate adult and child mortality, respectively. Their results indicated excess adult mortality in urban areas, particularly in recent years, in contrast with child mortality which remains higher in rural areas. It seems that for adults, the increased propagation of infectious diseases in densely populated and poorly serviced urban areas cancels out the advantage of better healthcare structures and higher overall living standards. This conclusion is surprising and merits more attentive examination, given the methodological problems of measuring inequalities via retrospective surveys. For example, to measure rural-urban differences in adult mortality, the authors had to assume that if a woman



had lived her entire life in a rural (or urban) area, the same was true of her siblings. According to Lankoande (2016), this hypothesis generates a risk of classification errors that might invalidate these authors' conclusions. Based on the case of Burkina Faso, he showed that data on deaths in the previous 12 months, on orphans and on the survival of siblings, can yield contradictory conclusions about urban-rural differences if the effect of migration is not taken into account.

All in all, in the absence of complete civil registration, it remains difficult to draw conclusions on spatial inequalities in adult mortality, even at a level as general as the distinction between urban and rural areas.

It is easier to demonstrate inequalities when vital statistics data are available, even if the place of death (and its registration) sometimes differs from the place of residence of the deceased, thus creating an incompatibility between numerator and denominator in the calculation of mortality. In South Africa, for example, various adjustments are needed to analyse adult mortality by province. Dorrington et al. (2004) estimated mortality by province based on death registration data for the period 1985-1996, and found life expectancy differences of more than 10 years. More recently, Pillay-van Wyk and colleagues (2016) updated mortality estimates by province in South Africa for the period 1997-2012, and confirmed the higher mortality in the province of Kwazulu-Natal (whose age-standardized crude death rate is 1.7 times higher than that of Western Cape province). These spatial inequalities are partly determined by differences in the magnitude of the HIV/AIDS epidemic.

### *Spatial inequalities in adult mortality in countries affected by HIV/AIDS*

The AIDS epidemic has redefined spatial inequalities in mortality in countries where prevalence is high. It was determined at an early stage that HIV does not evolve at the same rate in different residential environments, due to the greater frequency of risk behaviours in the city. For this reason, the monitoring of these epidemics, initially structured around HIV tests in prenatal clinics, now distinguishes between rural and urban settings. The inclusion of HIV tests in general population surveys has confirmed that HIV prevalence is higher in urban areas. For example, García-Calleja and colleagues (2006) analysed 20 surveys carried out in sub-Saharan Africa, and showed that in half of them, the urban-rural prevalence ratio was above 1.7. More recently, it has been shown that in some countries, such as Namibia, there are few differences between residential environments, but large inequalities between regions (Mahy et al., 2014). In recent years, a number of countries, such as Mozambique and Nigeria, have monitored the epidemic at the sub-national level, revealing wide spatial heterogeneity. In 12 countries of sub-Saharan Africa where provincial-level data on HIV prevalence are available, the ratio between the highest and lowest prevalences is above 5 (UNAIDS, 2013).



#### 4. Limited knowledge of social inequalities in adult mortality

In high-income countries, there is an abundant literature attesting to inequalities in adult mortality, generally measured by level of education, income, and occupational category (Link and Phelan, 1995). Almost universally, adult mortality is higher among people with a lower level of education and a lower income, and among inactive persons and manual workers. The scale of these inequalities varies enormously, depending on the countries and the individual variables analysed. This variability reflects the more or less egalitarian nature of social and economic policies (Kunst and Mackenbach 1994), differences in tobacco and alcohol consumption and in access to healthcare (Mackenbach et al., 2008). Moreover, social inequalities in adult mortality seem to have increased in recent decades (Deboosere P. et al., 2009; Jemal et al., 2008; Murphy et al., 2006), particularly for smoking-related deaths (Montez and Zajacova, 2013).

In low- and middle-income countries, there are no available data to compare inequalities in adult mortality at the international level or track changes over time. A few studies have been carried out at the local level through health and demographic surveillance systems, as in Ethiopia (Berhane et al., 2002), Bangladesh (Hurt et al., 2004), and Vietnam (Huong et al., 2006). Studies have been conducted, at the national level, notably in India (Subramanian et al., 2006), the Seychelles (Stringhini et al., 2014), and Brazil (Chiavegatto Filho et al., 2014). Some of these highlight the importance of adjusting the data to correct for the variable quality of death reporting in different social groups. Chiavegatto Filho et al. (2014) provide an illustration with regard to inequalities in mortality between “races” (in the terminology of Brazilian public statistics).<sup>(56)</sup> Analyses of the 2010 census without correction for under-reporting and missing data suggest that the differences between whites, individuals of mixed ancestry (*pardos*), and blacks are small (on the order of 2 years of life expectancy at most). The authors’ adjustment led to an advantage of whites: 2.9 and 8.5 years for white women relative to mixed and black women, respectively, and 5.1 and 9.3 years for men.

The literature available for Brazil (Belon et al., 2012; Duncan et al., 1995) and India (Subramanian et al., 2006) suggests that social inequalities in mortality in these countries are at least as large as those in high-income countries. They are greater in young adults and in men. In India, for example, Subramanian et al. (2006) estimated that for young adults in the poorest quintile, the risk of death over a period of two years was nearly three times higher than for those in the richest quintile. Among older adults, the differences remain substantial but decrease with increasing age: the excess mortality ratio was 1.97 among adults aged 45-64 years and 1.17 among those aged 65 and over. The size of these inequalities also varies by cause of death: inequalities are larger for deaths associated with accidents and violence, and for those

(56) The same problem can occur with living standard, level of education, and residential environment.

linked to alcoholism (cirrhosis of the liver). There are also major social inequalities in mortality from infectious and respiratory diseases.

There is much debate on the size and direction of social inequalities in HIV-AIDS mortality. The conclusions of research on social inequalities in HIV infection do not always run in the most expected direction. For example, Fortson (2008) observed that in five African countries, the most educated adults were more likely to be infected, apparently because education is positively associated with the frequency of sexual activity before marriage. Other studies have shown a negative relationship between HIV infection and wealth (Fox, 2010). According to Hargreaves et al. (2008), the relationship between HIV infection and education (and potentially wealth) may have varied over time. They observe that studies published on this subject before 1996 found no association, or a greater risk of infection among the most educated, whereas more recent studies have shown the opposite. This could be explained by a shift in attitudes; at the beginning of the epidemic, educated individuals were more inclined to engage in risky sexual behaviours (Gregson et al., 2001), but they have since adjusted their behaviour in response to awareness campaigns (Glynn et al., 2004). Consequently, the inverse relationship between education and mortality may have been a temporary situation, typical of the early days of the epidemic, followed by a return to a small mortality advantage for the most educated.

## 5. Decreasing maternal mortality

The mortality indicator that best captures the continuing inequalities between countries around the world is unquestionably the maternal mortality ratio (number of maternal deaths per 100,000 live births).

Each day there are more than 800 maternal deaths<sup>(57)</sup> in low- and middle-income countries, even though a large majority are avoidable. The Millennium Development Goals aimed to reduce maternal mortality by three quarters between 1990 and 2015. Worldwide, maternal mortality decreased from 385 deaths per 100,000 live births in 1990 to 216 in 2015 (Alkema et al., 2016). Progress thus fell far short of the 75% objective. Only nine low- and middle-income countries reached this ambitious target.<sup>(58)</sup> Today, under the new post-2015 agenda set by the Sustainable Development Goals, the target is to decrease maternal mortality to below 70 deaths per 100,000 live births worldwide by 2030. Due to the lack of data, mainly from countries with incomplete civil registration, monitoring of progress in this domain is still based on estimates obtained using statistical models that combine data from surveys, censuses, and other sources (Alkema et al., 2016).

(57) Maternal death is the the death of a woman while pregnant or within 42 days of termination of pregnancy, irrespective of the duration and site of the pregnancy, from any cause related to or aggravated by the pregnancy or its management but not from accidental or incidental causes.

(58) Bhutan, Cambodia, Cape Verde, Timor-Leste, Iran, Laos, the Maldives, Mongolia and Rwanda.

These global estimates indicate that inequalities between groups of countries have narrowed, as maternal mortality has decreased fastest in low-income countries (–2.8% per year), followed by middle-income countries (–2.6% per year, versus –1.6% in high-income countries). However, in 2015, across these countries, maternal mortality still ranged from 4 deaths per 100,000 births in Belarus to 1,360 in Sierra Leone.<sup>(59)</sup> On average, the rate was 495 maternal deaths per 100,000 live births in low-income countries, 253 in lower middle income countries, and 55 in upper middle income countries. Expressed in the form of a lifetime risk of dying from maternal causes, these disparities grow vastly larger: in low-income countries, a 15-year-old woman has a one in 41 chance of dying from maternal causes over her lifetime, versus one in 220 in middle-income countries and one in 3,300 in high-income countries (WHO, 2016). The risk is highest in sub-Saharan Africa, at an estimated one in 36, and this region alone accounts for two thirds of maternal deaths worldwide. In 2015, across sub-Saharan Africa, only 2% of these maternal deaths were indirectly caused by AIDS, but the proportion is as high as 32% in South Africa (WHO, UNICEF, UNFPA, World Bank, UN Population Division, 2015). This proportion should decrease in coming years thanks to the introduction of antiretroviral treatments.

In addition to the previously mentioned social changes, such as improvements in girls' education, three positive trends have lowered maternal mortality over the last 25 years. First, antenatal care coverage has increased worldwide. In 2012, across all low- and middle-income countries, around 83% of pregnant women had attended at least one prenatal visit (World Bank, 2016). Second, birth attendance by skilled personnel has been improving. This intervention is key to reducing maternal mortality, as most maternal deaths occur during delivery or in the following hours. Third, family planning services have expanded.

Despite these improvements, coverage of these essential interventions remains highly uneven. The indicator of healthcare coverage for which inequalities are greatest – between rich and poor households, between different levels of education, and between residential environments – is the proportion of births attended by skilled personnel (WHO, 2015b). On average (across 26 countries), according to Rutstein et al. (2016), the proportion of women giving birth in a maternity clinic is 94% in large cities, 89% in towns and 55% in rural areas. There is also evidence of progress in this domain, which is variable but real: although the initial level was admittedly much higher, it is among the poorest women, notably in rural areas, that home delivery has decreased the most. In Burkina Faso, it fell from 64% to 35% in just 7 years (2003-2010), and in Egypt (2000-2014) from 65% to 16%. In Nigeria, on the other hand, as in other domains, progress has been minimal: from 74% in 2003 to 68% in 2013.

(59) In 2015, the lowest rate worldwide was 3 deaths per 100,000 births in Finland.

Access to antenatal care also remains patchy. It is widely available, on average, in cities (above 90% of pregnancies), but much less so in rural areas, particularly among the very poor (61%), although advances have been made in the last 10 to 15 years. Progress has been remarkable in Burkina Faso, where the figure increased from 73% to 95%, and even more so in Egypt (from 56% to 90%), while in Nigeria it remains at 64% (Rutstein et al., 2016).

## V. A protracted epidemiological transition, with patterns that vary across social groups

Tracking the ongoing epidemiological transition in low- and middle-income countries and evaluating the size of inequalities in cause-specific mortality remains a difficult exercise, due to the lack of data on causes of death (Mathers et al., 2005). In some countries, such as Brazil, most deaths are registered and their causes are certified by a physician, which means that disparities in cause-specific mortality can be analysed directly. However, a considerable proportion of deaths are from unknown or miscoded causes (18% between 2002 and 2004), thus limiting the scope and robustness of the conclusions drawn from Brazilian vital statistics (Franca et al., 2008).

In most countries, the situation is far from satisfactory. In India, more than three quarters of the 9.5 million deaths each year still occur at home, most without medical attendance (Jha et al., 2006). Consequently, statistics drawn from healthcare facilities are not representative of deaths overall. Causes of death are established on the basis of verbal autopsies, i.e. questionnaires administered to family members of the deceased to gather information on the circumstances of death and the symptoms of the illness that preceded it. In India, verbal autopsies have been central to the health information system since a vast survey, known as the Million Death Study, was implemented to fill gaps in the Sample Registration System (SRS) by providing information on the diseases leading to death (Bassani et al., 2010; Jha et al., 2006). For example, the survey produced an estimate of 205,000 deaths caused by malaria, a figure ten times higher than WHO estimates (Dhingra et al., 2010). Because the survey is representative at the national level, it also confirmed the existence of very large disparities in cause-specific mortality between states. For example, pneumonia mortality is five times higher among girls between the ages of 1 month and 5 years in the four central states<sup>(60)</sup> than among boys of the same age in the southern states<sup>(61)</sup> (Bassani et al., 2010). By contrast, adult suicide mortality is particularly high in the southern states (Patel et al., 2012).

Verbal autopsies, whether interpreted by physicians or analysed using statistical models, are often used in health and demographic surveillance

(60) Chhattisgarh, Madhya Pradesh, Rajasthan and Uttar Pradesh.

(61) Andhra Pradesh, Karnataka, Kerala and Tamil Nadu.

systems. In sub-Saharan Africa, they are practically the only source of data on causes of death, as regular statistics on causes of death are not available for any country in the region (excepting South Africa; Joubert et al., 2013). A recent analysis of 22 health and demographic surveillance systems in Asia and sub-Saharan Africa highlighted the extremely diverse epidemiological profiles of these different surveillance sites, sometimes even at the sub-national level, when there are several sites in one country (Streatfield et al., 2014). In Kenya for example, life expectancy in the populations covered by the Kisumu health and demographic surveillance system on the shores of Lake Victoria is extremely low (under 50 years), and HIV/AIDS is the leading cause of death (Odhiambo et al., 2012), whereas the life expectancy on the Kilifi site, located 800 km away, on the coast of the Indian Ocean, is more than 70 years, and residents die mainly of cardiovascular diseases (Scott et al., 2012). A few censuses, such as that of Mozambique in 2007, have been followed by specific surveys involving verbal autopsies, and in a few capitals, such as Antananarivo (Madagascar), high-quality data are available (Masquelier et al., 2014b). Nevertheless, in the region as a whole, the lack of data remains a major issue.

To establish estimates that are comparable for all countries, statistical models must be used. In recent years, the Global Burden of Disease (GBD) study has become the reference on cause-specific mortality (GBD collaborators, 2016). Its international team assembled a large database including information from surveys, censuses, hospital data, and many other sources, in order to estimate mortality and the incidence of diseases and injuries in every country of the world. One of the reasons for the project was that researchers and organizations specializing in certain diseases tended to over-estimate the number of deaths caused by specific pathologies (tuberculosis, AIDS, etc.), with the result that combining these estimates yielded a total considerably higher than estimates of the overall number of deaths (produced for example by the WHO). The GBD study ensures consistency between cause-specific estimates and total mortality.

Overall, the trends that have emerged from this monumental effort tend to confirm expectations. The increase in life expectancy seen in most countries has been accompanied by profound changes in the distribution of deaths across causes, broadly reflecting the model of the “epidemiological transition” described by Abdel Omran (1971, 1998). In this model, there is a long-term shift from a regime with high mortality and a high proportion of deaths from infectious diseases to a regime with low mortality characterized by chronic, non-communicable diseases closely linked to individual behaviours (inadequate diet, alcoholism, smoking, etc.). According to GBD estimates, between 1990 and 2015, the proportion of deaths in low-income countries due to communicable, maternal, neonatal and nutritional diseases dropped from 67% to 52% (GBD collaborators, 2016).<sup>(62)</sup> In middle-income countries, the transition is much

---

(62) The distribution of causes of death can be explored for each country in the world using the GBD compare tool: <https://vizhub.healthdata.org/gbd-compare/>

more advanced: in 2015, these causes accounted for only 29% of deaths in lower middle income countries, and 8% in upper middle income countries. To examine these changes in detail, we can classify the principal causes of death in 1990 and 2015, in the ten selected countries, on the basis of estimates from the 2015 GBD study (GBD collaborators, 2016) (Table 9A and 9B).<sup>(63)</sup>

In 1990, the main category of causes of death in six of the ten countries included diseases associated with diarrhoea, infections of the lower respiratory tract, and other infections (meningitis, measles, etc.). In the four other countries (China, South Africa, Brazil, Egypt), cardiovascular diseases were already the leading cause of death in 1990 (all ages combined). These have caused a growing proportion of deaths in recent decades, except in South Africa and Nigeria, where HIV/AIDS and tuberculosis have increased (to the point of becoming the leading category of causes of death in South Africa since the 2000s). In contrast, whereas in many cases diarrhoeal diseases, lower respiratory tract infections and other infections (meningitis, measles) represented the first or second-leading category of causes of death in 1990, their ranking has fallen almost everywhere. The exceptions are Burkina Faso and Nigeria, where these diseases continue to cause the largest proportion of deaths, as child mortality in the two countries remains high. In both countries, malaria also remains widespread, and is the second-leading cause of death. Overall, the decrease in child mortality is also reflected by a smaller contribution of causes associated with the neonatal period. In 1990 these were among the six leading categories of causes of death, but in the last 25 years they have fallen several places in the ranking. These estimates also illustrate the growing importance of cancers, which, in Bolivia for example, climbed from fifth to second place between 1990 and 2015, and in Indonesia from fifth to third place. Diabetes (along with urogenital, blood, and endocrine diseases) also rose in several of the within-country rankings, becoming the second-leading cause of death in Indonesia, and the fourth-leading cause in China and India.

Broadly speaking, these changes fit the model of the epidemiological transition, with the notable exception of the HIV-AIDS epidemic and tuberculosis, which have marked an upsurge in communicable diseases. Although Omran's model has been widely debated, notably because it minimizes the positive contributions of medical interventions and improvements in public health (Caldwell, 2001; Mackenbach, 1994; Santosa et al., 2014; Vallin and Meslé, 2004), it nonetheless remains useful for making sense of changes in the hierarchy of causes of death. However, in its original formulation, it leaves little space for the question of inequalities in mortality. Instead it rests on a classical idea of convergence to low levels of mortality and a distribution of causes of death typical of high-income countries. But the transitions observed in low- and middle-income countries are very diverse in terms of speed and timing, and

---

(63) These estimates established for all countries worldwide must be interpreted with caution, as in many cases they are based on incomplete and uncertain data (Jha, 2014).

in certain cases they have substantially deviated from the path predicted by the model.

A number of alternative models have been proposed, some of which give more space to the question of inequalities. For middle-income countries, Frenk et al. (1989) introduced the “protracted and polarized” transition model to describe a pathway distinct from the one taken by western countries. It is “protracted” in that, rather than being organized sequentially, the various steps can overlap for some time, leading to the coexistence of infectious diseases and nutritional deficiencies with non-communicable diseases. A number of large cities in sub-Saharan Africa, such as Ouagadougou in Burkina Faso, face this “double burden” of disease (Zeba et al., 2012).

Counter-transitions can also occur, such as the resurgence of malaria in the 1980s and 1990s in sub-Saharan Africa due to the emergence of chloroquine-resistant parasites (Trape et al., 1998). The HIV/AIDS epidemic, and more recently the epidemic of Ebola haemorrhagic fever in 2014, are other cases of counter-transitions. For example, using data collected at Agincourt, in a rural area of South Africa, Kahn et al. (2007) documented a 12-year decrease in women’s life expectancy and a 14-year decrease in that of men over the period 1992-2003 due to HIV/AIDS and, in the same period, an increase in adult mortality from non-communicable diseases. These counter-transitions reflect the fragility of health advances in low- and middle-income countries when they are mainly attributable to medical progress that is not necessarily accompanied by lasting improvements in living conditions or healthcare systems (Masquelier et al., 2014b).

According to Frenk et al. (1989), this model is also “polarized” because it is associated with a widening of inequalities in health and mortality within certain countries, as the transition occurs at different rates in different sub-populations. On the one hand, the least advantaged social groups face higher mortality, mainly due to infections, while on the other, the most affluent groups are more exposed to non-communicable diseases. Population are thus in competition for healthcare resources. Agyei-Mensah and Graft Aikins (2010) offer a clear description of this situation in Accra, the capital of Ghana. They attribute the “protracted and polarized” character of the transition to three essential factors: rapid urbanization (which notably creates problems of public hygiene), the urban poverty that accompanies it, and the emergence of new behaviours, notably new eating habits, which lead to hypertension, diabetes, and obesity.

Overall, this model of protracted and polarized transition can be useful to describe the changes under way in low- and middle-income countries, but due to the lack of detailed data on causes of death at the national scale, it remains difficult to determine its applicability beyond a few particular case studies.



Table 9A. Rankings of the leading causes of death in 1990 in 10 countries  
(by categories of diseases causing the most deaths)

	South Africa	China	Brazil	Bolivia	Egypt	India	Indonesia	Nigeria	Afghanistan	Burkina Faso
<b>Non-communicable diseases</b>										
Cardiovascular diseases	1	1	1	2	1	2	2	5	2	5
Neoplasms	3	2	3	5	6	7	5	6	6	6
Diabetes, urogenital, blood, and endocrine diseases	4	9	7	6	5	8	7	7	9	10
Chronic respiratory diseases	8	3	8	12	7	4	6	13	8	16
Cirrhosis	15	11	10	7	3	11	11	11	15	15
<b>Communicable, maternal, neonatal and nutritional diseases</b>										
Diarrhoeal diseases, lower respiratory tract infections, and other infections	2	4	2	1	2	1	1	1	1	1
Neonatal disorders	5	6	4	3	4	3	4	3	3	3
HIV/AIDS and tuberculosis	7	12	14	13	15	5	3	9	12	4
Nutritional deficiencies	14	16	15	10	18	17	13	5	19	8
Maternal disorders	18	18	19	16	13	15	12	12	11	14
Malaria and neglected tropical diseases	20	19	16	19	17	13	15	2	14	2
<b>External causes</b>										
Self-harm and interpersonal violence	6	7	5	11	16	16	18	17	10	17
Transport injuries	9	8	6	8	12	10	8	14	7	13
Unintentional injuries	10	5	9	4	9	6	9	8	4	7
<i>Interpretation:</i> Each number represents the rank of each cause of death in the country.										
<i>Source:</i> GBD 2015 Study, <a href="https://vizhub.healthdata.org/gbd-compare/">https://vizhub.healthdata.org/gbd-compare/</a>										



**Table 9B. Rankings of the leading causes of death in 2015 in 10 countries  
(by categories of diseases causing the most deaths)**

	South Africa	China	Brazil	Bolivia	Egypt	India	Indonesia	Nigeria	Afghanistan	Burkina Faso
<b>Non-communicable diseases</b>										
Cardiovascular diseases	2	1	1	1	1	1	1	5	1	3
Neoplasms	3	2	2	2	4	6	3	6	6	5
Diabetes, urogenital, blood, and endocrine diseases	4	4	3	4	3	4	2	7	8	10
Chronic respiratory diseases	7	3	5	8	6	3	6	13	9	16
Cirrhosis	13	9	10	5	2	12	8	11	13	15
<b>Communicable, maternal, neonatal and nutritional diseases</b>										
Diarrhoeal diseases, lower respiratory tract infections, and other infections	5	8	4	3	5	2	4	1	2	1
Neonatal disorders	9	13	13	6	9	5	9	3	5	4
HIV/AIDS and tuberculosis	1	12	12	15	17	7	5	4	15	6
Nutritional deficiencies	16	18	16	13	19	18	14	10	19	8
Maternal disorders	18	20	20	18	18	17	17	12	12	12
Malaria and neglected tropical diseases	20	19	17	16	20	15	15	2	17	2
<b>External causes</b>										
Self-harm and interpersonal violence	6	10	6	11	13	11	16	19	10	17
Transport injuries	8	5	8	12	10	9	10	17	7	11
Unintentional injuries	11	7	9	7	11	8	11	8	4	7
<i>Interpretation:</i> Each number represents the rank of each cause of death in the country.										
<i>Source:</i> GBD 2015 Study, <a href="https://vizhub.healthdata.org/gbd-compare/">https://vizhub.healthdata.org/gbd-compare/</a>										

## **VI. Is mortality across countries converging or diverging? Is inequality within countries decreasing?**

“Death, disease and health remain a timeless and universal source of inequalities” (Tabutin, 1995). These words, written more than 20 years ago, remain valid today. In the 1970s and 1980s, the first notable reductions in child mortality were confirmed in the Global South, in many cases dating back to the 1950s and 1960s. But at the same time, inequalities across countries and between social groups within countries persisted or were even on the increase (Akoto and Tabutin, 1989; Cleland et al., 1992). Given the economic and health conditions of the time (structural adjustment plans, economic crisis, the emergence of AIDS, recurring poverty), some feared that these regional and social disparities would widen in Latin America, South Asia, and Africa.

Overall, a phase of divergence between low and middle-income countries in the 1990s (due notably to the health crisis in Russia and the former Soviet states and to AIDS; Moser et al., 2005), was followed by a phase of convergence beginning in around 2005. Inequalities decreased with the control and treatment of AIDS in adults, lower maternal mortality, a considerable intensification of international action, and improved effectiveness of programmes to combat childhood infectious diseases. However, these developments took place at variable rates, depending on concomitant developments in national health policies, education, and living standards. Many studies have stated or implied that global convergence is under way. Is this really the case?

Clear progress in life expectancy was observed in the 1990s (setting aside countries most affected by the AIDS epidemic), with an acceleration in the 2000s. Today, in most countries, and particularly the poorest, mortality has fallen to levels that were not anticipated 15 or 20 years ago. These large declines have occurred at all ages, but among the youngest above all. They have notably benefited girls and women, and have occurred in all social groups (as approximately defined by level of education or living standard, and place of residence), but they have occurred at widely varying rates.

At these unprecedented levels of mortality, and at this new stage of the epidemiological transition currently under way in many countries, are inequalities between regions and countries, and within countries really narrowing? Incontestable progress is evident virtually everywhere, but is it accurate to speak of a global convergence? Are there not persistent disparities in the situations of different groups? These questions are crucial for the definition of priorities at both national and international levels, as defined in the Sustainable Development Goals (SDGs) for 2015-2030.

We believe it is premature to speak of convergence. Despite the real progress that has been achieved, inequalities among these low- and middle-income countries remain substantial. Life expectancy differentials have narrowed only slightly: in 2015 the difference between upper middle income and low-income

countries was still 13 years, and that between sub-Saharan Africa and East Asia 18 years. Inequalities between countries, which were immense in 1990 (life expectancies ranging from 37 to 76 years at the extremes), were still so in 2015 (from 49 to 80 years). Within countries, under-5 mortality has decreased rapidly in almost all social groups, often (but not always) to the benefit of the poorest. The control of infectious diseases (notably through vaccination) and diarrhoeal diseases has decreased social inequalities in many cases, but it has done so to a highly variable extent across different countries and societies. Situations continue to be very heterogeneous. History shows that mortality transitions take multiple paths.

What developments can be expected in new and emerging epidemiological contexts, with the growing weight of non-communicable diseases linked to behaviours (diet, alcohol, tobacco), the environment (pollution), and ageing populations? It is possible to combat and control these new health threats (neoplasms, diabetes, stroke, accidents, congenital disorders), but doing so requires adequate technologies and healthcare infrastructure, clear political will, and substantial financial means. In the context of growing macroeconomic inequalities at the world level, piecemeal privatization of healthcare systems, and rising living costs for most populations,<sup>(64)</sup> there is reason to fear persistent or even deepening inequalities between countries or between social groups within countries. As early as 2004, McMichael et al. expressed concern about this prospect in the following terms: “Gains in longevity could be less smooth and less certain than earlier notions of convergence suggested. The impediments to convergence include: persistence of health gradients both within and among countries, reflecting deleterious socioeconomic and political conditions, often with unequal access to health-care, increases in various infectious diseases, especially those associated with poverty... and the health risks consequent on large-scale environmental changes caused by human pressures” (*The Lancet*, 2004, p. 1156).

Striking a more optimistic but nonetheless prudent note, the international Commission on the Social Determinants of Health, created on the initiative of the WHO, concluded its summary report on health inequalities (Marmot et al., 2008) with these words: “Is closing the gap in a generation possible? This question has two clear answers. If we continue as we are, there is no chance at all. If there is a genuine desire to change, if there is a vision to create a better and fairer world... the answer is yes. In calling to close the gap in a generation, we do not imagine that the social gradient in health within countries, or the great differences between countries, will be abolished in 30 years. But the evidence encourages us that significant closing of the gap is indeed achievable... This is a long term agenda, requiring major changes in social policies, economic arrangements and political action” (*The Lancet*, 2008, p. 1668).

---

(64) Not to mention major wars, conflicts, and environmental risks.

In his analysis of inequalities in child mortality (from 85 surveys and 29 countries) between 2002 and 2012, Bendavid (2014) confirmed a degree of convergence overall in levels of mortality within different countries, but also highlighted that it is far from universal, with inequalities increasing in nearly one in four countries.

In their very recent analysis of child health and poverty in cities of the Global South (26 countries), Rutstein et al. (2016) confirmed the advantage of living in cities and observed a limited decrease in mortality inequalities within them, but also expressed concern about the scale of poverty and the growth of extreme poverty in most of these large cities, which could slow or reverse this progress.

The conclusions of research in this domain, while tentatively optimistic, remain prudent overall. We will need to await the results of the most recent surveys, for the years 2013-2017, before we can analyse the 2010s and perhaps the years beyond. Demography always has a time lag of 5 to 10 years with respect to events, because of its reliance on retrospective data collection and measurement instruments (paragraphs I.2 and I.3).

## **VII. Uncertainties and knowledge gaps: consolidating research on mortality and its inequalities**

The issue of geographic and social inequalities in health and mortality has long been a key research theme in terms of both knowledge and action – first in developed countries from the 1960s onward, and then more recently in the Global South (Elo, 2009). The problems involved are complex, and their study requires rigour and caution. In low- and middle-income countries, most of which lack reliable civil registration, measuring levels of mortality on the basis of surveys or censuses is never a simple affair. Measuring inequalities at a given time, and, above all, how they change over time, is still more difficult, with its dependence on survey protocols, random and non-random errors, choices of indicators, etc. Most demographic research takes a predominantly descriptive approach to mortality differentials, based on a few standard variables such as education, level of economic well-being, and place of residence. Three points deserve particular attention: sources of information, methods (indicators, variables), and important avenues for future research.

### **1. Information sources**

Most research on trends and inequalities in mortality is based on surveys along the lines of DHS and MICS, which are particularly well suited to studying child mortality. They are less reliable for studying adult mortality (estimates based on the survival of close relatives), and almost unusable for a fine-grained approach to geographical or social disparities due to the small sample sizes in most of these surveys.

Too little use is made of censuses: and yet these are the only sources – if of sufficient quality – that can yield a precise geography of mortality levels and inequalities, between provinces or districts within countries, between neighbourhoods within large cities, or between clearly defined social groups (by occupation, for example). Censuses also make it possible to include various types of community or contextual variables in “explanatory” analyses.

Vital statistics, in the few countries (or cities) where they are reliable, are also neglected overall; yet, at a relatively fine geographical level, they constitute the best instrument for tracking changes in causes of death in almost real time, and also to learn about certain characteristics of the deceased. They are insufficiently used, and sometimes the data are not even entered into the relevant systems. In the last 15 years, UNICEF, and more recently the World Bank and the WHO, have rightly called for a greater focus on the use of vital statistics, and have supported projects in the poorest countries in particular (World Bank and WHO, 2014).

International support for data collection and research on health and mortality in different populations must be continued and even strengthened throughout the world, and in particular in the poorest countries where statistical systems are the weakest. This is a vital duty of national governments and must be taken into account in public policies to promote research and reduce inequalities.

## 2. Methods

For countries without vital statistics, a broad range of techniques for measuring child and adult mortality, both direct and indirect, are available to demographers and can be used in surveys and censuses. Each has its advantages and limitations, and even when drawing upon the same dataset, can sometimes yield different results. Recent advances have been achieved in this area, notably under the ægis of the United Nations (research by the UN IGME for example), but also in academic groups (such as the IHME, with the Global Burden of Disease Study). Progress on the still more complex issue of inequalities remains more limited. What tools should be developed to track trends in inequalities over time?

As to the differential variables – we dare not call them “explanatory” – of inequality, they are most often chosen from the standard list: place of residence, mother’s level of education and, above all, a proxy for living standard based on relative measures (quintiles) as defined by the DHS surveys on the basis of household wealth reported. Yet in contexts of economic progress, many households may experience improvement in their economic well-being while remaining in the same quintile. Moreover, few studies integrate father’s level of education, family structure, conjugal status, or indeed more community-level or contextual variables (availability of healthcare, sanitation, water, electricity). These variables are essential for a better understanding of how social inequalities emerge and evolve in a given context.

Beyond censuses, which often take place every ten years at most, how might we move down to geographically finer analyses of mortality, which in surveys are limited to a few large regions or two or three residential environments? This question is important for the implementation of more targeted health policies, but it remains complex in the absence of civil registration and effective, decentralized health information systems. Health and demographic surveillance systems, for their part, cover only a very small, often relatively homogeneous population.

### 3. A few suggestions for further research

This review concludes with a few suggestions for developing new avenues of research on mortality.

Despite population ageing, mortality beyond age 60 continues to be widely neglected, as research concentrates on children and, to a lesser extent, working-age adults. Conducting such studies presents a real methodological challenge, as aside from a few countries with good civil registration, standard information systems (surveys, censuses) and the associated methods of estimation do not cover older populations.

It would be useful to conduct comparative meta-analyses on transitions in mortality and health in a few countries, some having experienced real convergence, others not. This type of large-scale research would involve a multi-disciplinary approach, with analysis of national social, healthcare, demographic, and economic policies in relationship to health and mortality, the study of determinants in various social groups, and the role of international development.

An increase in research on environments of both relative and extreme poverty is urgently needed, both in cities and in rural areas, using appropriate tools, both quantitative and qualitative. For example, what are the barriers to the take-up of healthcare services? What are the factors behind poor – often very poor – access to vaccination, pre- or post-natal care, and medical attendance? These questions are by no means new, but they are essential to the study of inequalities.

Questions of gender merit further attention in the study of inequalities. How much freedom do women enjoy in the most disadvantaged groups to improve their health and that of their children? Who decides, who pays? Here too, qualitative studies can provide information that goes beyond what can be gleaned from quantitative data.

A substantial reinforcement of research, both fundamental and applied, is indispensable, to define policies and interventions, ensure greater efficacy, and develop more effective follow-up in the coming years. This is not a task for demographers alone, but they have their role to play.



## APPENDIX

Appendix Table. Levels of child and adult mortality (both sexes), maternal mortality and life expectancies (both sexes) in 1990 and 2015

Country	Infant mortality ( ${}_1q_0$ - %) <sup>(1)</sup>		Under-five mortality ( ${}_5q_0$ - %) <sup>(2)</sup>		Adult mortality ( ${}_{45}q_{15}$ - %) <sup>(3)</sup>		Maternal mortality ratio <sup>(4)</sup>		Life expectancy <sup>(5)</sup>	
	1990	2015	1990	2015	1990	2015	1990	2015	1990	2015
High-income countries	13	6	15	7	136	100	15	10	74	79
Upper middle income countries	43	15	56	20	155	112	114	54	68	74
South Africa	47	34	60	40	294	440	108	138	62	57
Albania	35	12	41	14	110	67	71	29	72	78
Algeria	40	22	47	26	177	110	216	140	67	75
Angola	134	96	226	157	438	342	1160	477	41	53
Azerbaijan	76	28	95	32	158	132	64	25	65	71
Belarus	14	3	17	5	198	210	33	4	70	71
Bosnia-Herzegovina	16	5	18	5	164	98	28	11	71	77
Botswana	42	35	54	44	271	304	243	129	62	64
Brazil	51	15	61	16	227	143	104	44	65	75
Bulgaria	18	9	22	10	160	138	25	11	71	74
China	42	9	54	11	136	85	97	27	69	76
Colombia	29	14	35	16	196	141	118	64	68	74
Costa Rica	14	8	17	10	108	87	43	25	76	80
Cuba	11	4	13	6	128	90	58	39	75	80
Ecuador	44	18	57	22	168	125	185	64	69	76
Gabon	60	36	93	51	250	242	422	291	61	65
Iraq	42	26	54	32	207	164	107	50	66	70
Iran	45	13	58	16	246	84	123	25	63	76
Jamaica	25	14	31	16	158	133	79	89	72	76
Jordan	30	15	37	18	155	111	110	58	70	74
Kazakhstan	45	13	53	14	214	212	78	12	67	69
Lebanon	27	7	32	8	151	61	74	15	70	80
Libya	36	11	42	13	170	136	39	9	68	72
Macedonia	33	5	37	6	131	102	14	8	71	76
Malaysia	14	6	17	7	163	122	79	40	71	75
Mauritius	20	12	23	14	198	145	81	53	69	75
Mexico	37	11	47	13	168	111	90	38	71	77
Mongolia	77	19	108	22	235	216	186	44	60	70
Namibia	50	33	74	45	270	284	338	265	61	65
Panama	26	15	31	17	136	116	102	94	73	78
Paraguay	37	18	46	20	176	146	150	132	68	73
Peru	56	13	80	17	182	124	251	68	66	75
Dominican Republic	46	26	60	31	201	162	198	92	68	74
Romania	31	10	38	11	183	137	124	31	70	75
Serbia	24	6	28	7	153	115	14	17	71	75
Thailand	30	10	37	12	181	156	40	20	70	75
Tunisia	44	12	57	14	165	98	131	62	69	75
Turkmenistan	72	44	90	51	230	224	82	42	63	66
Turkey	56	12	74	14	182	106	97	16	64	76



Appendix Table (cont'd). Levels of child and adult mortality (both sexes), maternal mortality and life expectancies (both sexes) in 1990 and 2015

Country	Infant mortality ( ${}_1q_0$ - %) <sup>(1)</sup>		Under-five mortality ( ${}_5q_0$ - %) <sup>(2)</sup>		Adult mortality ( ${}_{45}q_{15}$ - %) <sup>(3)</sup>		Maternal mortality ratio <sup>(4)</sup>		Life expectancy <sup>(5)</sup>	
	1990	2015	1990	2015	1990	2015	1990	2015	1990	2015
Lower middle income countries	83	40	119	53	239	191	533	251	59	67
Armenia	42	13	50	14	180	117	58	25	68	75
Bangladesh	100	31	144	38	197	129	569	176	59	72
Bolivia	86	31	124	38	290	186	425	206	55	69
Cameroon	86	57	138	88	325	356	728	596	54	56
Congo	61	33	94	45	341	264	603	442	55	63
Côte d'Ivoire	105	67	153	93	342	406	745	645	52	52
Egypt	63	20	86	24	188	152	106	33	65	71
Georgia	41	11	48	12	150	115	34	36	70	75
Ghana	80	43	127	62	284	248	634	319	57	62
Guatemala	60	24	81	29	262	180	205	88	62	72
Honduras	45	17	58	20	208	148	272	129	67	73
India	88	38	126	48	262	180	556	174	58	68
Indonesia	62	23	85	27	200	176	446	126	63	69
Kenya	66	36	102	49	287	270	687	510	58	62
Kyrgyzstan	54	19	65	21	200	180	80	76	66	71
Laos	111	51	162	67	335	194	905	197	54	67
Lesotho	71	69	88	90	285	588	629	487	59	50
Morocco	63	24	80	28	196	96	317	121	65	74
Mauritania	78	65	118	85	245	205	859	602	58	63
Moldava	27	14	33	16	220	170	51	23	67	72
Myanmar	78	40	110	50	280	200	453	178	59	66
Nicaragua	51	19	67	22	226	148	173	150	64	75
Nigeria	126	69	212	109	386	360	1350	814	46	53
Uzbekistan	59	34	72	39	184	184	54	36	67	69
Pakistan	106	66	139	81	210	161	431	178	60	66
Palestine	36	18	44	21	179	120	118	45	68	73
Papua New Guinea	65	44	89	57	384	275	470	215	56	63
Philippines	41	22	58	28	236	210	152	114	65	68
El Salvador	46	14	59	17	254	178	157	54	64	73
Senegal	70	42	140	47	254	189	540	315	57	67
Sudan	80	48	128	70	300	224	744	311	56	64
Sri Lanka	18	8	21	10	194	137	75	30	70	75
Swaziland	56	44	75	61	288	598	635	389	59	49
Syria	30	11	37	13	153	190	123	68	70	70
Tajikistan	85	38	108	45	183	162	107	32	63	70
Timor-Leste	132	45	176	53	390	150	1080	215	49	69
Ukraine	17	8	20	9	204	204	46	24	70	71
Vietnam	37	17	51	22	152	127	139	54	71	76
Yemen	89	34	126	42	274	222	547	385	58	64
Zambia	113	43	191	64	512	296	577	224	45	61

Appendix Table (cont'd). Levels of child and adult mortality (both sexes), maternal mortality and life expectancies (both sexes) in 1990 and 2015

Country	Infant mortality ( ${}_1q_0$ - %) <sup>(1)</sup>		Under-five mortality ( ${}_5q_0$ - %) <sup>(2)</sup>		Adult mortality ( ${}_{45}q_{15}$ - %) <sup>(3)</sup>		Maternal mortality ratio <sup>(4)</sup>		Life expectancy <sup>(5)</sup>	
	1990	2015	1990	2015	1990	2015	1990	2015	1990	2015
Low-income countries	113	53	187	76	375	256	1010	496	49	61
Afghanistan	122	66	181	91	377	258	1340	396	50	61
Benin	108	64	180	100	280	246	576	405	53	60
Burkina Faso	102	61	202	89	321	261	727	371	49	59
Burundi	104	54	172	82	366	295	1220	712	48	57
Cambodia	85	25	117	29	352	173	1020	161	53	69
North Korea	33	20	43	25	138	140	75	97	69	71
Eritrea	93	34	151	46	492	258	1590	501	48	64
Ethiopia	122	41	205	59	386	226	1250	353	47	64
The Gambia	80	48	170	69	324	262	1030	706	52	61
Guinea	141	61	238	94	290	270	1040	679	50	59
Guinea-Bissau	136	60	229	92	326	278	907	549	49	56
Haiti	101	52	146	69	325	244	625	359	55	63
Liberia	170	53	255	70	327	248	1500	725	48	61
Madagascar	98	36	161	50	340	221	778	353	51	66
Malawi	142	43	242	64	455	262	957	634	44	63
Mali	131	74	254	115	325	258	1010	587	46	59
Mozambique	160	57	240	78	418	400	1390	489	43	55
Nepal	98	29	141	36	327	156	901	258	54	70
Niger	138	57	328	96	306	221	873	553	44	62
Uganda	111	38	187	55	488	307	687	343	45	59
Central African Republic	115	92	176	130	381	395	1290	882	49	51
Dem. Rep. of Congo	120	74	186	98	360	264	879	693	49	59
Rwanda	93	31	152	42	545	228	1300	290	35	65
Sierra Leone	156	87	264	120	526	401	2630	1360	38	51
Somalia	108	85	180	137	396	314	1210	732	46	56
South Sudan	150	60	253	93	416	332	1730	789	44	56
Tanzania	100	35	165	49	390	259	997	398	50	65
Chad	116	85	215	139	388	366	1450	856	47	52
Togo	90	52	146	78	272	269	568	368	56	60
Zimbabwe	51	47	76	71	350	380	440	443	59	59
World	63	32	91	43	191	148	385	216	64	71

**Notes:** (1) Risk per 1,000 live births of dying between birth and the age of 1 year, under the mortality conditions of a given year.

(2) Risk per 1,000 live births of dying between birth and the age of 5 years, under the mortality conditions of a given year.

(3) Risk per 1,000 persons aged 15 years of dying before reaching the age of 60 years, under the mortality conditions of a given year.

(4) Number of maternal deaths per 100,000 live births.

(5) Number of years that a person could be expected to live if exposed throughout life to the mortality conditions of a given year.

**Sources:** UN IGME (2015) for infant and under-five mortality; United Nations (2015) for adult mortality and life expectancies; WHO, UNICEF, UNFPA, World Bank, UN Population Division (2015) for maternal mortality ratios.



## REFERENCES

- AGYEI-MENSAH S., DE GRAFT AIKINS A., 2010, "Epidemiological transition and the double burden of disease in Accra, Ghana", *Journal of Urban Health*, 87(5), pp. 879-897.
- AKOTO E.M., TABUTIN D., 1989, "Les inégalités socioéconomiques et culturelles devant la mort", in Pison G., van de Walle E., Sala-Diakanda M. (eds.), *Mortalité et société en Afrique*, Paris, INED, Cahier 124, pp. 35-63.
- ALKEMA L., NEW J.R., PEDERSEN J., YOU D., BASTIAN P. et al., 2014a, "Child mortality estimation 2013: An overview of updates in estimation methods by the United Nations Inter-agency Group for child mortality estimation", *PLoS ONE*, 9(7), e101112.
- ALKEMA L., CHAO F., YOU D., PEDERSON J., SAWYER C., 2014b, "National, regional, and global sex ratios of infant, child, and under-5 mortality and identification of countries with outlying ratios: A systematic assessment", *The Lancet Global Health*, 2(9), pp. e521-e530.
- ALKEMA L., CHOU D., HOGAN D., ZHANG S., MOLLER A.B. et al., 2016, "Global, regional and national levels and trends in maternal mortality between 1990 and 2015, with scenario-based projections to 2030: A systematic analysis by the UN Maternal Mortality Estimation Inter-Agency Group", *The Lancet*, 327(10017), pp. 462-474.
- AROKIASAMY P., 2007, "Sex ratio at birth and excess female child mortality in India: Trends, differentials and regional patterns", in Attané I., Guilmoto C. (eds.), *Watering the Neighbour's Garden: The Growing Demographic Female Deficit in Asia*, Paris, CICRED, pp. 49-72.
- ARRIAGA E.E., 1984, "Measuring and explaining the change in life expectancies", *Demography*, 21(1), pp. 83-96.
- ATTANE I., BARBIERI M., 2009, "The demography of East and Southeast Asia from the 1950s to the 2000s. A summary of changes and a statistical assessment", *Population, English Edition*, 64(1), pp. 7-146.
- BANNISTER J., 2004, "Shortage of girls in China today", *Journal of Population Research*, 21(1), pp. 19-45.
- BASSANI D.G., KUMAR R., AWASTHI S., MORRIS S.K., PAUL V.K. et al., 2010, "Causes of neonatal and child mortality in India: A nationally representative mortality survey", *The Lancet*, 376(9755), pp. 1853-1860.
- BELON A.P., BARROS M.B., MARIN-LEON L., 2012, "Mortality among adults: Gender and socioeconomic differences in a Brazilian city", *BMC Public Health*, 12(39).
- BENDAVID E., 2014, "Changes in child mortality over time across the wealth gradient in less-developed countries", *Pediatrics*, 134(6), pp. e1551-e1559.
- BENDAVID E., SELIGMAN B., KUBO J., 2011, "Comparative analysis of old-age mortality estimations in Africa", *PLoS ONE*, 6(10), e26607.
- BENDAVID E., HOLMED C., BHATTACHARYA J., MILLER G., 2012, "HIV development assistance and adult mortality in Africa", *Journal of American Medical Association*, 307(19), pp. 2060-2067.
- BERHANE Y., HOGBERG U., BYASS P., WALL S., 2002, "Gender, literacy, and survival among Ethiopian adults, 1987-1996", *Bulletin of the World Health Organization*, 80(9), pp. 714-720.

- BLACKER J., 2004, "The impact of AIDS on adult mortality: Evidence from national and regional statistics", *AIDS*, 18(Suppl 2), pp. 519-526.
- BOCQUIER P., MADISE N.J., ZULU E.M., 2011, "Is there an urban advantage in child survival in sub-Saharan Africa? Evidence from 18 countries in the 1990s", *Demography*, 48(2), pp. 531-558.
- BRÖCKERHOFF M., BRENNAN E., 1998, "The poverty of cities in developing regions", *Population and Development Review*, 24(1), pp. 75-114.
- CALDWELL J., 1979, "Education as a factor of mortality decline: An examination of Nigerian data", *Population Studies*, 33(3), pp. 395-413.
- CALDWELL J., 1986, "Routes to low mortality in poor countries", *Population and Development Review*, 12(2), pp. 171-220.
- CALDWELL J., 2001, "Population health in transition", *Bulletin of the World Health Organization*, 79(2), pp. 159-170.
- CANUDAS-ROMO V., SAIKIA N., DIAMOND-SMITH N., 2015, "The contribution of age-specific mortality towards male and female life expectancy differentials in India and selected states, 1970-2013", *Asia-Pacific Population Journal*, 30(2), pp. 1-20.
- CHIAVEGATTO FILHO A.D., BELTRAM-SANCHEZ H., KAWACHI I., 2014, "Racial disparities in life expectancy in Brazil: Challenges from a multiracial society", *American Journal of Public Health*, 104(11), pp. 2156-2162.
- CLELAND J., VAN GINNEKEN J., 1988, "Maternal education and child survival in developing countries: The search for pathways of influence", *Social Science and Medicine*, 27(12), pp. 1357-1368.
- CLELAND J., HARRIS K., 1998, "The effect of maternal education on child health and survival in the developing world", in United Nations (ed.), *Too Young to Die: Genes or Gender?*, New York, pp. 179-207.
- CLELAND J., BICEGO G., FEGAN G., 1992, "Socioeconomic inequalities in childhood mortality: The 1970s to the 1980s", *Health Transition Review*, 2(1), pp. 1-18.
- DAS GUPTA M., 2009, "Family systems, political systems and Asia's missing girls: The construction of son preference and its unraveling", *World Bank Policy Research Paper*, 5148, 34 p.
- DEBOOSERE P., GADEYNE S., VAN OYEN H., 2009, "The 1991-2004 evolution in life expectancy by educational level in Belgium based on linked census and population register data", *European Journal of Population*, 25(2), pp. 175-196.
- DE WALQUE D., FILMER D., 2011, "Trends and socioeconomic gradients in adult mortality around the developing world", The World Bank, Policy Research Working Paper 5716, 53 p.
- DHINGRA N., JHA P., SHARMA V.P., COHEN A., JOTKAR R. et al., 2010, "Adult and child malaria mortality in India: A nationally representative mortality survey", *The Lancet*, 376(9754), pp. 1768-1774.
- DOKUBO E.K., SHIRAISHI R.W., YOUNG P.W., NEAL J.J., ABERLE-GRASSE J. et al., 2014, "Awareness of HIV status, prevention knowledge and condom use among people living with HIV in Mozambique", *PLoS ONE*, 9(9), e106760.
- DORRINGTON R., TIMÆUS I., MOULTRIE T., NANAN N., 2004, "Estimates of provincial mortality and fertility in South Africa 1985-1996", *Southern African Journal of Demography*, 9(2), pp. 25-57.
- DUNCAN B., RUMEL D., ZELMANOWICZ A., DALMÁZ A., 1995, "Social inequality in mortality in São Paulo State, Brazil", *International Journal of Epidemiology*, 24(2), pp. 359-365.
- DYE C., 2008, "Health and urban living", *Science*, 319(5864), pp. 766-769.
- DYSON T., MOORE M., 1983, "On kinship structure, female autonomy and demographic behavior in India", *Population and Development Review*, 9(1), pp. 35-60.

- ELO I.T., 2009, "Social class differentials in health and mortality: Patterns and explanations in comparative perspective", *Annual Review of Sociology*, 35, pp. 553-572.
- FEENEY G., 2001, "The impact of HIV/AIDS on adult mortality in Zimbabwe", *Population and Development Review*, 27(4), pp. 771-780.
- FINK G., GUNTHER I., HILL K., 2014, "Slum residence and child health in developing countries", *Demography*, 51(4), pp. 1175-1197.
- FORTSON J., 2008, "The gradient in Sub-Saharan Africa: Socioeconomic status and HIV/AIDS", *Demography*, 45(2), pp. 303-322.
- FOX A., 2010, "The social determinants of HIV serostatus in sub-Saharan Africa: An inverse relationship between poverty and HIV?", *Public Health Reports*, 125(Suppl4), pp. 16-24.
- FRANCA E., DE ABREU D.X., RAO C., LOPEZ A., 2008, "Evaluation of cause-of-death statistics for Brazil, 2002-2004", *International Journal of Epidemiology*, 37(4), pp. 891-901.
- FRENK J., BOBADILLA J., SEPUALVEDA J., LOPEZ CERVANTES M., 1989, "Health transition in middle-income countries: New challenges for health care", *Health Policy and Planning*, 4(1), pp. 29-39.
- FUCHS R., PAMUK E., LUTZ W., 2010, "Education or wealth: Which matters more for reducing child mortality in developing countries", *Vienna Yearbook of Population Research*, 8(1), pp. 175-199.
- GAIGBE-TOGBE V., 2015, "The impact of socio-economic inequalities on early childhood survival: Results from the demographic and health surveys", United Nations, Population Division, *Technical Paper*, 2015/1, 30 p.
- GAKIDOU E., COWLING K., LOZANO R., MURRAY C., 2010, "Increased educational attainment and its effects on child mortality in 175 countries between 1970 and 2009: A systematic analysis", *The Lancet*, 376(9745), pp. 959-974.
- GARCÍA-CALLEJA J.M., GOUWS E., GHYS P., 2006, "National population based HIV prevalence surveys in sub-Saharan Africa: Results and implications for HIV and AIDS estimates", *Sexually Transmitted Infections*, 82(Suppl3), pp. iii64-70.
- GARENNE M., 2010, "Urbanisation and child health in resource-poor settings with special reference to under-five mortality in Africa", *Archives of Disease in Childhood*, 95(6), pp.464-468.
- GARENNE M., LAFON M., 1998, "Sexist diseases", *Perspectives in Biology and Medicine*, 41(2), pp. 176-189.
- GBD COLLABORATORS, 2016, "Global, regional and national life expectancy, all-cause mortality and cause-specific mortality for 249 causes of death, 1980-2015: A systematic analysis for the Global Burden of Disease Study 2015", *The Lancet*, 388(10053), pp. 1459-1544.
- GERLAND P., MASQUELIER B., HELLERINGER S., HOGAN D., MATHERS C.D., 2014, "Maternal mortality estimates", *The Lancet*, 384(9961), pp. 2211.
- GLYNN J., CARAEL M., BUVÉ A., ANAGONOU S., ZEKENG L. et al., 2004, "Does increased general schooling protect against HIV infection? A study in four African cities", *Tropical Medicine & International Health*, 9(1), pp. 4-14.
- GOULD W., 1998, "African mortality and the new urban penalty", *Health and Place*, 4(2), pp. 171-181.
- GRAHAM W., PHILA D., FITZMAURICE A., BELL J., CAIRNS J., 2004, "The familial technique for linking maternal death with poverty", *The Lancet*, 363(9402), pp. 23-27.
- GREGSON, S., WADDELL H., CHANDIWANA S., 2001, "School education and HIV control in sub-Saharan Africa: From discord to harmony?", *Journal of International Development*, 13(4), pp. 467-485.

- GREGSON S., NYAMUKAPA C.A., GARNETT G.P., MASON P.R., ZHUWAWU T. et al., 2002, "Sexual mixing patterns and sex-differentials in teenage exposure to HIV infection in rural Zimbabwe", *The Lancet*, 359(9321), pp. 1896-1903.
- GUILMOTO C.Z., 2015, "The masculinization of births. Overview and current knowledge", *Population, English Edition*, 70(2), pp. 183-244.
- GUILMOTO C.Z., 2016, "Mortality in China, India and Indonesia: An overview", in Guilmoto C.Z., Jones G.W. (eds.), *Contemporary Demographic Transformations in China, India and Indonesia*, Springer International Publishing Switzerland, pp. 89-94.
- GÜNTHER I., HARTTGEN K., 2012, "Deadly cities? Spatial inequalities in mortality in sub-Saharan Africa", *Population and Development Review*, 38(3), pp. 469-486.
- GWATKIN D.R., 2000, "Health inequalities and the health of the poor: What do we know? What can we do?", *Bulletin of the World Health Organization*, 78(1), pp. 3-18.
- HAJIZADEH M., NANDI A., HEYMAN J., 2014, "Social inequality in infant mortality: What explains variation across low and middle countries?", *Social Science and Medicine*, 101, pp. 36-46.
- HARGREAVES J., BONELL C., BOLER T., BOCCIA D., BIRDTTHISTLE I. et al., 2008, "Systematic review exploring time trends in the association between educational attainment and risk of HIV infection in sub-Saharan Africa", *AIDS*, 22(3), pp. 403-414.
- HILL K., UPCHURCH D.M., 1995, "Gender differences in child health: Evidence from the demographic and health surveys", *Population and Development Review*, 21(1), pp. 127-151.
- HOUWELING T., KUNST A.E., 2010, "Socio-economic inequalities in childhood mortality in low- and middle-income countries: A review of the international evidence", *British Medical Bulletin*, 93(1), pp. 7-26.
- HOUWELING T., KUNST A., LOOMAN C., MACKENBACH J., 2005, "Determinants of under-5 mortality among the poor and the rich: A cross-national analysis of 43 developing countries", *International Journal of Epidemiology*, 34(6), pp. 1257-1265.
- HUONG D.L., VAN MINH H., JANLERT U., VAN DO D., BYASS P., 2006, "Socio-economic status inequality and major causes of death in adults: A 5-year follow-up study in rural Vietnam", *Public Health*, 120(6), pp. 497-504.
- HURT L.S., RONSMANS C., SAHA S., 2004, "Effects of education and other socioeconomic factors on middle age mortality in rural Bangladesh", *Journal of Epidemiology and Community Health*, 58(4), pp. 315-320.
- IBGE, 2010, "Tabuas abreviadas de mortalidade por sexo e idade. Brazil, Grandes Regioes e Unidades da Federaçao", Rio de Janeiro, *Estudos e Pesquisas*, 30, 116 p.
- INSTITUTE FOR HEALTH METRICS AND EVALUATION (IHME), 2016, *Financing Global Health Visualization*, Seattle, University of Washington, IHME, <http://vizhub.healthdata.org/fgh/> (Consulted 26/11/2016)
- INDEPTH NETWORK, 2005, *Measuring Health Equity in Small Areas: Findings from Demographic Surveillance Systems*, Hants, Ashgate.
- JEMAL A., WARD E., ANDERSON R.N., MURRAY T., THUN M.J., 2008, "Widening of socioeconomic inequalities in U.S. death rates, 1993-2001", *PLoS ONE*, 3(5), e2181.
- JHA P., 2014, "Reliable direct measurement of causes of death in low- and middle-income countries", *BMC Medicine*, 12(1), pp. 19.
- JHA P., GAJALAKSHMI V., GUPTA P., KUMAR R., MONY P. et al., 2006, "Prospective study of one million deaths in India: Rationale, design and validation results", *PLoS Medecine*, 3(2), e18.

- JOUBERT J., RAO C., BRADSHAW D., VOS T., LOPEZ A.D., 2013, "Evaluating the quality of national mortality statistics from civil registration in South Africa, 1997-2007", *PLoS ONE*, 8(5), e64592.
- KAHN K., GARENNE M., COLLINSON M.A., TOLLMAN S.M., 2007, "Mortality trends in a new South Africa: Hard to make a fresh start", *Scandinavian Journal of Public Health*, 69, pp. 26-34.
- KASSEBAUM N., BERTOZZI-VILLA A., COGGESHALL M.S., SHACKELFORD K.A., STEINER C. et al., 2014, "Global, regional, and national levels and causes of maternal mortality during 1990-2013: A systematic analysis for the Global Burden of Disease Study 2013", *The Lancet*, 384(9947), pp. 980-1004.
- KHOSRAVI A., TAYLOR R., NAGHAVI M., LOPEZ A., 2007, "Differential mortality in Iran", *Population Health Metrics*, 5(7).
- KUNTLA S., GOLI S., JAIN K., 2014, "Explaining sex differentials in child mortality in India: Trends and determinants", *International Journal of Population Research*, article ID 649741, 7 p.
- KUNST A.E., MACKENBACH J.P., 1994, "The size of mortality differences associated with educational level in nine industrialized countries", *American Journal of Public Health*, 84(6), pp. 932-937.
- KYU H.H., SHANNON H., GEORGIADES K., BOYLE M., 2013, "Association of urban slum residency with infant mortality and child stunting in low and middle income countries", *BioMed Research International*, ID 604974, 12 p.
- LALOU R., LEGRAND T., 1997, "Child mortality in the urban and rural Sahel", *Population, An English Selection*, 9, pp. 147-168.
- LANKOANDE B., 2016, "Monitoring adult mortality by type of residence in the absence of death registration: A perspective from Burkina Faso", *International Journal of Population Studies*, 2(1), pp. 21-37.
- LANKOANDE B., SIÉ A., 2017, "Selective adult migration and urban-rural mortality differentials in Burkina Faso", *Population, English Edition*, 72(2), pp. 197-218.
- LE Y., REN J., SHEN J., LI T., ZHANG C.F., 2015, "The changing gender differences in life expectancy in Chinese cities 2005-2010", *PLoS One*, 10(4), 8 p.
- LI S., ZHU C., FELDMAN M.W., 2004, "Gender differences in child survival in contemporary rural China: A county study", *Journal of Biosocial Science*, 36, pp. 83-109.
- LINK B.G., PHELAN J., 1995, "Social conditions as fundamental causes of disease", *Journal of Health and Social Behaviour*, special issue, pp. 80-94.
- MACASSA G., GHILAGABER G., BERNHARDT E., DIDERICHSEN F., BURSTRÖM B., 2003, "Inequalities in child mortality in Mozambique: Differentials by parental socio-economic position", *Social Science and Medicine*, 57(12), pp. 2255-2264.
- MACKENBACH J.P., "The Epidemiologic Transition Theory", 1994, *Journal of Epidemiology and Community Health*, 48(4), pp. 329-331.
- MACKENBACH J.P., STIRBU I., ROSKAM A.J., SCHAAP M.M., MENVIELLE G. et al., 2008, "Socioeconomic inequalities in health in 22 European countries", *The New England Journal of Medicine*, 358(23), pp. 2468-2481.
- MAHY M., NZIMA M., OGUNGBEMI M.K., OGBANG D.A., MORKA M., STOVER J., 2014, "Redefining the HIV epidemic in Nigeria: From national to state level", *AIDS*, 28(4), pp. S461-S467.
- MAIGA A., BOCQUIER P., 2016, "Dynamiques urbaines et santé des enfants en Afrique subsaharienne: perspectives théoriques", *Études de la population africaine*, 30(1), pp. 2213-2226.



- MARMOT M., FRIEL S., BELL R., HOUWELING T., TAYLOR S., 2008, "Closing the gap in a generation: Health equity through action on the social determinants of health", *The Lancet*, 372(9650), pp. 1661-1669.
- MASQUELIER B., EATON J. W., GERLAND P., PELLETIER F., MUTAI K., 2017, "Age patterns and sex ratios of adult mortality in countries with high HIV prevalence", *AIDS*, 31, pp. S77-S85.
- MASQUELIER B., RENIERS G., PISON G., 2014a, "Divergences in trends in child and adult mortality in sub-Saharan Africa: Survey evidence on the survival of children and siblings", *Population Studies*, 68(2), pp. 161-177.
- MASQUELIER B., WALTISPERGER D., RALIJAONA O., PISON G., RAVELO A., 2014b, "The epidemiological transition in Antananarivo, Madagascar: An assessment based on death registers (1900-2012)", *Global Health Action*, 7(1), 13 p.
- MASUY-STROOBANT G., 2005, "Theories and frameworks for the study of child mortality", in Caselli G., Vallin J., Wunsch G. (eds.), *The Determinants of Mortality*, II, Academic Press, pp. 237-246.
- MATHERS C.D., FAT D.M., INOUE M., RAO C., LOPEZ A., 2005, "Counting the dead and what they died from: An assessment of the global status of cause of death data", *Bulletin of the World Health Organization*, 83(3), pp. 171-177.
- MCMICHAEL A., MCKEE M., SHKOLNIKOV V., VALKONEN T., 2004, "Mortality trends and setbacks: Global convergence or divergence?", *The Lancet*, 363(9415), pp. 1155-1159.
- MONTEZ J.K., ZAJACOVA A., 2013, "Trends in mortality risk by education level and cause of death among US White women from 1986 to 2006", *American Journal of Public Health*, 103(3), pp. 473-479.
- MOSLEY W., CHEN L., 1984, "An analytical framework for the study of child survival in developing countries", *Population and Development Review*, 10(Suppl.), pp. 25-45.
- MUJICA O., VAZQUEZ E., DUARTE E., CORTEZ-ESCALANTE J., MOLINA J., SILVA JUNIOR J., 2014, "Socioeconomic inequalities and mortality trends in BRICS, 1990-2010", *Bulletin of the World Health Organization*, 92, pp. 405-413.
- MURPHY M., BOBAK M., NICHOLSON A., ROSE R., MARMOT M., 2006, "The widening gap in mortality by educational level in the Russian Federation, 1980-2001", *American Journal of Public Health*, 96(7), pp. 1293-1299.
- MUULA S., NQULUBE J., SIZIYA S., MAKUPE M., UMAR E. et al., 2007, "Gender distribution of adult patients on highly active antiretroviral therapy in Southern Africa: A systematic review", *BMC Public Health*, 7(63), 8 p.
- MONTGOMERY M., 2009, "Urban poverty and health in developing countries", Population Reference bureau, *Population Bulletin*, 64(2), 16 p.
- MOSER K., SHKOLNIKOV V., LEON D., 2005, "World mortality 1950-2000: Divergence replaces convergence from the late 1980s", *Bulletin of the World Health Organization*, 83(3), pp. 202-209.
- MOULTRIE T., DORRINGTON R., HILL K., TIMÆUS I., ZABA B., 2013, *Tools for Demographic Estimation*, Paris, IUSSP, 433 p.
- NATHANSON C., 1984, "Sex differences in mortality", *Annual Review of Sociology*, 10(1), pp. 191-213.
- NDIRANGU J., NEWELL M.L., THORNE C., BLAND R., 2012, "Treating HIV-infected mothers reduces under 5 years of age mortality rates to levels seen in children of HIV-uninfected mothers in rural South Africa", *Antiviral Therapy*, 17(1), pp. 81-90.
- ODHIAMBO F., LASERSON K., SEWE M., HAMEL M., FEIKIN D.R., et al., 2012, "Profile: The KEMRI/CDC health and demographic surveillance system-western Kenya", *International Journal of Epidemiology*, 41(4), pp. 977-987.



- OLIVEIRA J. DE CASTRO, ALBUQUERQUE F.R., 2005, *O mortalidade no Brasil no período 1980-2004: desafios e oportunidades para os próximos anos*, Rio de Janeiro, IBGE, 42 p.
- OMRAN A.R., 1971, "The epidemiologic transition: A theory of the epidemiology of population change", *Milbank Memorial Fund Quarterly*, 49(4), pp. 509-538.
- OMRAN A.R., 1998, "The epidemiologic transition theory revisited 30 years later", *World Health Statistics Quarterly*, 51(2-4), pp. 99-119.
- PATEL V., RAMASUNDARAHETTIGE C., VIJAYAKUMAR L., THAKUR J., GAJALAKSHMI V. et al., 2012, "Suicide mortality in India: A nationally representative survey", *The Lancet*, 379(9834), pp. 2343-2351.
- PILLAY-VAN WYK V., MSEMBURI W., LAUBSCHER R., DORRINGTON R.E., GROENWALD P. et al., 2016, "Mortality trends and differentials in South Africa from 1997 to 2012: Second National Burden of Disease Study", *The Lancet Global Health*, 4(9), pp. e642- e653.
- RAJARATNAM J.K., MARCUS J.R., LEVIN-RECTOR A., CHALUPKA A.N., WANG H. et al., 2010, "Worldwide mortality in men and women aged 15-59 years from 1970 to 2010: A systematic analysis", *The Lancet*, 375(9727), pp. 1704-1720.
- RAM U., JHA P., GERLAND P., HUM R.J., RODRIGUEZ P. et al., 2015, "Age-specific and sex-specific adult mortality risk in India in 2014: Analysis of 0.27 million nationally surveyed deaths and demographic estimates from 597 districts", *The Lancet Global Health*, 3(12), pp. e767-e775.
- RAMIRO-FARINAS D., ORIS M., 2016, *New Approaches to Death in Cities during the Health Transition*, New York, Springer, 241 p.
- RANDALL S., COAST E., 2016, "The quality of demographic data on older Africans", *Demographic Research*, 34(5), pp. 143-174.
- RENIERS G., SLAYMAKER E., NAKIYINGI-MIRO J., NYAMUKAPA C., CRAMPIN A.C. et al., 2014, "Mortality trends in the era of antiretroviral therapy: Evidence from the network for analysing longitudinal population based HIV/AIDS data on Africa (ALPHA)", *AIDS*, 28(4), pp. S533-S542.
- REGIDOR E., 2004a, "Measures of health inequalities: Part 1", *Journal of Epidemiology and Community Health*, 58(11), pp. 858-861.
- REGIDOR E., 2004b, "Measures of health inequalities: Part 2", *Journal of Epidemiology and Community Health*, 58(11), pp. 900-903.
- ROGERS R.G., EVERETT B.G., SAINT-ONGE J.M., KRUEGER P.M., 2010, "Social, behavioral, and biological factors, and sex differences in mortality", *Demography*, 47(3), pp. 555-578.
- RUTSTEIN S., STAVETEIG S., WINTER R., YOURKAVITCH J., 2016, "Urban child poverty, health and survival in low- and middle income countries", *DHS Comparative Reports*, 40, Rockville, Maryland, USA, ICF International, 111 p.
- SAIKIA N., JASILIONIS D., RAM F., SHKOLNIKOV V., 2010, "Trends in geographical mortality differentials in India", Rostock, MPIDR Working Paper, 2009-013, 33 p.
- SAIKIA N., 2016, "Trends in mortality differentials in India", in Guilmoto C.Z., Jones G.W. (eds.), *Contemporary Demographic Transformations in China, India and Indonesia*, Springer International Publishing Switzerland, pp. 55-71.
- SAMUEL O., HERTRICH V., 2016, "Structures familiales, encadrement communautaire et survie des enfants. Une recherche en milieu rural malien", *African Population Studies*, 30(1), pp. 2160-2176.
- SANTOSA A., WALL S., FOTTRELL E., HOGBERG U., BYASS P., 2014, "The development and experience of epidemiological transition theory over four decades: A systematic review", *Global Health Action*, 15(7), pp. 23574.

- SASTRY N., 1997, "What explains rural-urban differentials in child mortality in Brazil?", *Social Science and Medicine*, 44(7), pp. 989-1002.
- SAWYER C.C., 2012, "Child mortality estimation: Estimating sex differences in childhood mortality since the 1970s", *PLOS Medicine*, 9(8), e1001287, 18 p.
- SHELL C.O., REILLY M., ROSLING H., PETERSON S., EKSTRÖM M., 2007, "Socioeconomic determinants of infant mortality: A worldwide study of 152 low-, middle- and high-income countries", *Scandinavian Journal of Public Health*, 35(3), pp. 288-297.
- SCOTT J.A., BAUNI E., MOISI J., OJAL J., GATAKAA H. et al., 2012, "Profile; The Kilifi health and demographic surveillance system (KHDSS)", *International Journal of Epidemiology*, 41(3), pp. 650-657.
- SOEMANTRI S., AFIFA T., 2016, "Mortality trends in Indonesia", in Guilimoto C.Z., Jones G.W. (eds.), *Contemporary Demographic Transformations in China, India and Indonesia*, Springer International Publishing Switzerland, pp. 73-86.
- SOURA B.A., 2009, *Analyse de la mortalité des enfants à Ouagadougou. Inégalités spatiales, effets individuels et contextuels*, Louvain-la-Neuve, Presses universitaires de Louvain, 279 p.
- STREATFIELD P.K., KHAN W.A., BHUIYA A., ALAM N., SIÉ A. et al., 2014, "Cause-specific mortality in Africa and Asia: Evidence from INDEPTH health and demographic surveillance system sites", *Global Health Action*, 7, 25362.
- STUCKLER D., BASU S., MCKEE M., 2010, "Drivers of inequality in Millennium Development Goal progress: A statistical analysis", *PLoS Med*, 7(3), 13 p.
- STRINGHINI S., ROUSSON V., VISWANATHAN B., GEDEON J., PACCAUD F., BOVET P., 2014, "Association of socioeconomic status with overall and cause specific mortality in the Republic of Seychelles: Results from a cohort study in the African region", *PLoS One*, 9(7), e102858.
- SUBRAMANIAN S.V., NANDY S., IRVING M., GORDON D., LAMBERT H. SMITH G., 2006, "The mortality divide in India: The differential contributions of gender, caste, and standard of living across the life course", *American Journal of Public Health*, 96(5), pp. 818-825.
- TABUTIN D., 1978, "La surmortalité féminine en Europe avant 1940", *Population*, 33(1), pp. 121-148.
- TABUTIN D., 1995, "Transitions et théories de mortalité", in Gérard H. and Piché V. (eds.), *La sociologie des populations*, Presses de l'Université de Montréal, AUPELF/UREF, pp. 257-288.
- TABUTIN D., WILLEMS M., 1995, "Excess female child mortality in the developing world during the 1970s and 1980s", *Population Bulletin of the United Nations*, 39, pp. 45-78.
- TABUTIN D., GOURBIN C., BENINGUISSE G., 2007, "Surmortalité et santé des petites filles en Afrique. Tendances des années 1970 aux années 2000", in Locoh T. (ed.), *Genre et sociétés en Afrique. Implications pour le développement*, Paris, INED, Cahier 160, pp. 137-169.
- TABUTIN D., SCHOUMAKER B., 2004, "The demography of sub-Saharan Africa from the 1950s to the 2000s. A survey of changes and a statistical assessment", *Population, English Edition*, 59(3-4), pp. 457-556.
- TIMÆUS I., 1984, "Mortality in Lesotho: A study of levels, trends and differentials based on retrospective data", International Statistical Institute, WFS Scientific Reports, 59, 53 p.
- TIMÆUS I., JASSEH M., 2004, "Adult mortality in Sub-Saharan Africa: Evidence from demographic and health survey", *Demography*, 41(4), pp. 757-772.

- TRAPE J., PISON G., PREZIOSI M., ENEL C., DESGRÉES DU LOÛ A. et al., 1998, "Impact of chloroquine resistance on malaria mortality", *Comptes rendus de l'Académie des Sciences*, Paris, Série 3, Sciences de la vie, 321(8), pp. 689-697.
- UNAIDS, 2013, "Location, location. Connecting people faster to HIV services", Geneva, Switzerland, [http://www.unaids.org/sites/default/files/media\\_asset/LocationLocation\\_en.pdf](http://www.unaids.org/sites/default/files/media_asset/LocationLocation_en.pdf)
- UNAIDS, 2015, "How AIDS changed everything", report accessible at [http://www.unaids.org/en/resources/documents/2015/MDG6\\_15years-15lessonsfromtheAIDSresponse](http://www.unaids.org/en/resources/documents/2015/MDG6_15years-15lessonsfromtheAIDSresponse), consulted 28/11/2016.
- UNESCO, INSTITUTE FOR STATISTICS, 2014, *UNESCO eAtlas of Literacy*, Montreal.
- UNICEF, 2015, "Committing to child survival, a promise renewed", 12 p., report accessible at: [https://www.unicef.pt/docs/pdf\\_publicacoes/a-promise-progress-report.pdf](https://www.unicef.pt/docs/pdf_publicacoes/a-promise-progress-report.pdf), consulted in November 2016.
- UN IGME (UNITED NATIONS INTER-AGENCY GROUP FOR CHILD MORTALITY ESTIMATION), 2015, "Levels and Trends in Child Mortality: 2015 Report", UNICEF-WHO-WB, Geneva 32 p.
- UNITED NATIONS, 1998, *Too Young to die: genes or gender?*, New York, United Nations, Population Division, ST/ESA/SER.A/155, 260 p.
- UNITED NATIONS, 2011, *Sex Differentials in Childhood Mortality*, New York, United Nations, Population Division, 254 p.
- UNITED NATIONS, 2013, *World Mortality Report 2013*, United Nations, Population Division, ST/ESA/SER.A/347, 106 p.
- UNITED NATIONS, 2014, *World Urbanization Prospects, The 2014 Revision*, New York United Nations, Population Division, 32 p.
- UNITED NATIONS, 2015, *World Population Prospects. The 2015 Revision*, New York, United Nations, Population Division, 66 p.
- VALLIN J., 2005, "Mortality, sex and gender", in Caselli G., Vallin J., Wunsch G. (eds.), *Demography: Analysis and Synthesis, II - The Determinants of Mortality*, Academic Press, pp. 177-194.
- VALLIN J., MESLÉ F., 2004, "Convergences and divergences in mortality: A new approach to health transition", *Demographic Research*, Special Collection 2, pp. 11-44.
- WALDRON I., 1998, "Levels and trends of sex differentials in infant, child and under-five mortality", in United Nations (ed.), *Too Young to Die: Genes or Gender?*, New York, pp. 84-108.
- WHO, UNICEF, UNFPA, WORLD BANK, UN POPULATION DIVISION, 2015, *Trends in Maternal Mortality: 1990 to 2015*, Geneva, WHO, 12 p.
- WHO, 2015a, *Health in 2015 from Millennium Development Goals (MDGs) to Sustainable Development Goals (SDGs)*, Geneva, 204 p., available at <http://www.who.int/gho/publications/mdgs-sdgs/en/>, consulted in November 2016.
- WHO, 2015b, *State of Inequality. Reproductive, Maternal, Newborn and Child Health*, Geneva, 103 p.
- WHO, 2016, *Global Health Observatory Data Repository*, database available at <http://apps.who.int/gho/data>, consulted in September 2016.
- WORLD BANK, 2016, *World Development Indicators*, Washington, database accessible at <http://datacatalog.worldbank.org/>, consulted in November 2016.
- WORLD BANK, WHO, 2014, "Global civil registration and vital statistics: Scaling up investment plan 2015-2024", <http://www.worldbank.org/en/topic/health/publication/global-civil-registration-vital-statistics-scaling-up-investment>

ZEBA A., DELISLE H., RENIER G., SVADOGO B., BAYA B., 2012, “The double burden of malnutrition and cardiometabolic risk widens the gender and socio-economic health gap: A study among adults in Burkina Faso (West Africa)”, *Public Health Nutrition*, 15(12), pp. 2210-2219.

ZHAO Z., CHEN W., JIN Y., 2016, “Recent mortality trends in China”, in Guilmoto C.Z., Jones G.W. (eds.), *Contemporary Demographic Transformations in China, India and Indonesia*, Springer International Publishing Switzerland, pp. 37-51.

### Dominique TABUTIN and Bruno MASQUELIER • MORTALITY INEQUALITIES AND TRENDS IN LOW- AND MIDDLE-INCOME COUNTRIES, 1990-2015

Between 1990 and 2015, life expectancy increased substantially in most low- and middle-income countries, although progress was very uneven. This article provides an overview of trends in early childhood mortality (0-5 years) and adult mortality (15-60 years) in the 109 low- and middle-income countries with populations of more than one million. It analyses trends in geographical and gender disparities across countries, and patterns of within-country inequalities (education, living standards, place of residence) in ten countries with very different socioeconomic, political and demographic characteristics (Afghanistan, Bolivia, Brazil, Burkina Faso, China, Egypt, India, Indonesia, Nigeria, South Africa). It takes a new look at the epidemiological transition and makes a detailed analysis of AIDS mortality and maternal deaths. Progress has benefited children especially, and often (though not always) women and the most disadvantaged countries or social groups. It would be premature to speak of mortality convergence, however, since despite the progress made, inequalities between and within countries remain large and deserve particular attention from public health policy makers and scientists.

### Dominique TABUTIN et Bruno MASQUELIER • TENDANCES ET INÉGALITÉS DE MORTALITÉ DE 1990 À 2015 DANS LES PAYS À REVENU FAIBLE ET INTERMÉDIAIRE

Entre 1990 et 2015, la plupart des pays en développement ont connu des progrès notables de leur espérance de vie, mais d'ampleur très diverse. Cet article fait le point sur l'évolution de la mortalité des enfants (à moins de 5 ans) et de la mortalité adulte (de 15 à 60 ans) dans les 109 pays à bas et moyen revenu de plus d'un million d'habitants. Il met l'accent sur l'évolution des disparités géographiques et de sexe entre pays, et sur les inégalités internes (instruction, niveaux de vie, milieux d'habitat) dans dix pays retenus aux caractéristiques très différentes sur les plans socioéconomique, politique et démographique (Afghanistan, Afrique du Sud, Bolivie, Brésil, Burkina Faso, Chine, Égypte, Inde, Indonésie, Nigeria). Il revisite également la question de la transition épidémiologique et examine plus particulièrement la mortalité par sida et la mortalité maternelle. Les progrès ont bénéficié principalement aux enfants, et souvent (mais pas toujours) aux femmes et aux pays et groupes sociaux les plus défavorisés. Parler de convergence vers une faible mortalité paraît néanmoins prématuré, car en dépit des progrès réalisés, les inégalités entre pays et internes aux pays demeurent conséquentes, et méritent une attention particulière tant des acteurs de la santé publique que des chercheurs.

### Dominique TABUTIN y Bruno MASQUELIER • TENDENCIAS Y DESIGUALDADES DE MORTALIDAD DE 1990 A 2015 EN LOS PAÍSES DE RENTA BAJA E INTERMEDIA

Entre 1990 y 2015, la mayor parte de países en desarrollo han conocido progresos notables de la esperanza de vida, pero de alcance muy diverso. Este artículo examina la evolución de la mortalidad de los niños (menores de 5 años) y de la mortalidad adulta (de 15 a 60 años,) en 109 países de renta baja o intermedia de más de un millón de habitantes. Pone el acento en la evolución de las diferencias geográficas y de género entre países, y en las desigualdades internas (instrucción, nivel de vida, tipo de hábitat) en 10 países con características muy diferentes en el plano socio-económico, político y demográfico (Afganistán, África del Sur, Bolivia, Brasil, Burkina Faso, China, Egipto, India, Indonesia y Nigeria). El artículo reconsidera también la cuestión de la transición epidemiológica y examina más específicamente la mortalidad por sida y la mortalidad materna. Los progresos beneficiaron principalmente a los niños y frecuentemente, aunque no siempre, a las mujeres y a los países y grupos sociales más desfavorecidos. Sin embargo, hablar de convergencia hacia una baja mortalidad es prematuro, pues a pesar de los progresos realizados las desigualdades entre países y entre grupos de población son todavía importantes y exigen una atención particular tanto de los actores de la salud pública como de los investigadores.

---

**Keywords:** child and adult mortality (1990-2015), social and geographic inequalities, gender, causes of death, AIDS, maternal mortality, epidemiological transition, low- and middle-income countries

Translated by Madeleine Grieve and Paul Reeve

